New Scientist

WEEKLY 7 September 2024

THE LITTLE-KNOWN BRAIN CELLS THAT KEEP YOU MENTALLY SHARP

WHY THE US MILITARY IS LAUNCHING ITS OWN SPY BALLOONS

HOW CLOUDS BECAME THE BIGGEST CLIMATE MYSTERY

RECLAIMING REALITY

Quantum theory stole our notion of what is real – now we want it back

No3507 £6.95 CAN$9.99

PLUS
CLOTHES MADE FROM POTATOES / WORLD'S FASTEST BACKFLIP / RISKIEST SPACEWALK EVER / **HOW LARGE CAN ANIMALS BE?**

Big electric performance in a small package

The Volvo EX30, now available with free home charger

Discover our fully electric EX30. It travels up to 295 miles on a single charge* and has the smallest CO_2 footprint of any Volvo car to date**. Made with recycled materials, featuring advanced Safe Space technology and an immersive sound experience with Harmon Kardon Premium Sound. Order before the end of September to get a free home charger worth £975***.

Order online or at your local retailer.

Fuel economy and CO results for the Volvo EX30: Mpg (l 100km): Not applicable, CO emissions: 0 g/km, electric range 209.4 – 295.8 miles. These figures were obtained after the battery had been fully charged. The Volvo EX30 is a battery electric vehicle requiring mains electricity for charging. The electric range shown was achieved using the new (WLTP) test procedure. Figures shown are for comparability purposes. Only compare fuel consumption, CO and electric range figures with other cars tested to the same technical procedures. These figures may not reflect real life driving results, which will depend upon a number of factors including the starting charge of the battery, accessories fitted (post-registration), variations in weather, driving styles and vehicle load.

*Based on Volvo EX30 Single Motor Extended Range Plus.

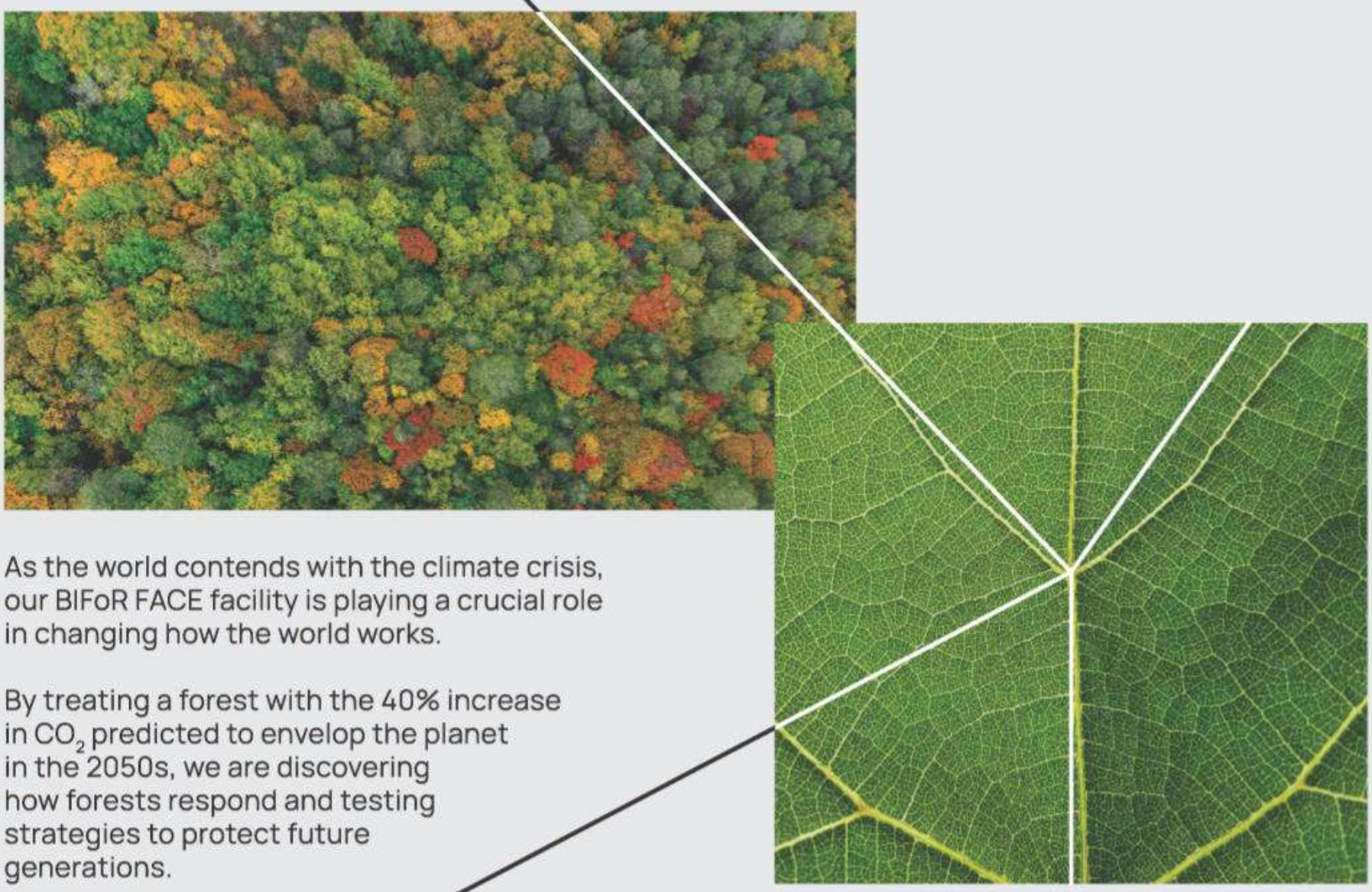
** Based on lifecycle CO_2 emissions over 200,000 kms of driving using charging electricity from the EU27 energy mix. Relates to globally available products.

*** Offer available to retail customers on new model year 2024 EX30 stock cars ordered and delivered between 1/7/2024 and 30/9/2024. Not available with subscription purchases. Standard installation only. UK residents. 18 and over. Terms and conditions and further eligibility apply. Subject to availability. Visit us to find out more.

VOLVO

UNIVERSITY OF BIRMINGHAM

Revealing the effects of climate change on forests of the future



As the world contends with the climate crisis, our BIFoR FACE facility is playing a crucial role in changing how the world works.

By treating a forest with the 40% increase in CO_2 predicted to envelop the planet in the 2050s, we are discovering how forests respond and testing strategies to protect future generations.

Find out how

We research
We activate

birmingham.ac.uk

This week's issue

On the cover

32 Reclaiming reality
Quantum theory stole our notion of what is real – now we want it back

New Scientist
RECLAIMING REALITY
Quantum theory stole our notion of what is real – now we want it back
CLOTHES MADE FROM POTATOES
HOW LARGE CAN ANIMALS BE?

Vol 263 No 3507
Cover image: Ryan Wills/ Eberhard Grossgasteiger

40 The little-known brain cells that keep you mentally sharp

13 Why the US military is launching its own spy balloons

36 How clouds became the biggest climate mystery

9 Clothes made from potatoes
16 World's fastest backflip
8 Riskiest spacewalk ever
46 How large can animals be?

32 Features

"They're trying to unscramble the quantum omelette one spoonful at a time"

News

10 'Impossible' galaxies
A reason why mysterious distant objects are so dense

11 You talkin' to me?
Marmosets are first non-human primates shown to use names for each other

14 Disease spreaders
Mosquito-borne illnesses are spiking around the world

Views

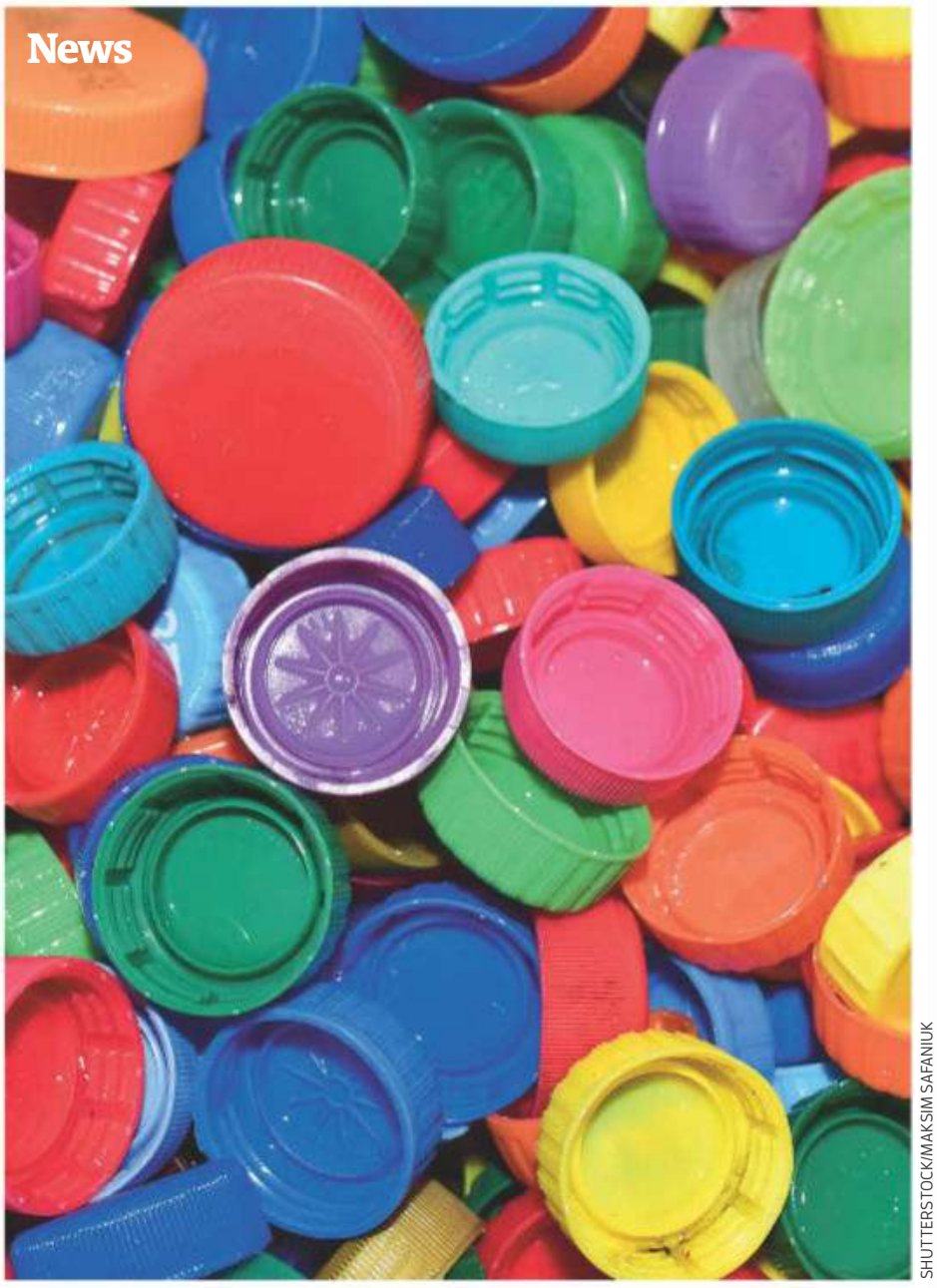
21 Comment
Media portrayals of addiction peddle a dangerous fiction, says Anna Wolfe

22 The columnist
Annalee Newitz on social media disinformation

24 Aperture
A view into the world of seeds

26 Letters
The case for and against an Alan Turing chatbot

28 Culture
The author of *Sapiens* tries to tackle info networks



SHUTTERSTOCK/MAKSIM SAFANIUK

17 Fantastic for plastic Vaporising could lead to better recycling

Features

32 Reality's comeback
An audacious attempt to win back a recognisable reality

36 Cloud gazing
New ways of studying clouds are helping us fathom whether they will hasten global warming

40 Brain savers
Mobile cells called microglia are inspiring revolutionary treatments for dementia

The back pages

44 Stargazing at home
Will comet Tsuchinshan-ATLAS make an appearance in October?

45 Puzzles
Try our crossword, quick quiz and logic puzzle

46 *Almost* the last word
What is the largest size an animal can be?

47 Tom Gauld for *New Scientist*
A cartoonist's take on the world

48 Feedback
Pressing questions about poking cysts and picky eaters

Elsewhere on New Scientist

NS Live

A life of crime

For many years, popular TV shows have given the public an idealistic picture of crime-scene science. Hear forensic scientist Anne Coxon compare and contrast the media portrayal of forensic science with reality, and why she thinks this has created unrealistic expectations of its role in the courts. See her on 12 October at New Scientist Live, online or in person at London's ExCeL Centre.

newscientist.com/nslmag

Tour

Arctic expedition: Svalbard, Norway

Explore the northernmost region of Earth, the realm of the polar bear and the midnight sun, while travelling aboard a purpose-built expedition ship. This cruise will include shore visits, Zodiac boat safaris and a full programme of talks – including from Richard Dawkins – covering topics including glaciology, marine biology, astronomy and the history of polar exploration.

newscientist.com/tours

Podcast

CultureLab

Ever wondered how your teenage years shaped the person you are today? Or why rebellious behaviour, like underage drinking, seems almost inevitable, no matter which generation you look at? Adolescent psychologist Lucy Foulkes explains why this period is often so challenging and shares tips on how adults can help young people navigate this tricky stage of growing up.

newscientist.com/nspod

N.C/ALAMY LIVE NEWS/ALAMY

Looking for clues Are our ideas of forensic science flawed?

SHUTTERSTOCK/LASSE JOHANSSON

Icy world Experience the extraordinary wonders of the Arctic

Video

The lab of life

Get a glimpse inside the Origins and Habitability Lab at NASA's Jet Propulsion Laboratory in Pasadena, California. Here, to work out how life might have started, geologists, biologists, chemists and engineers come together to understand the ways geological conditions might affect life in environments such as those on early Earth, Mars, icy moons and exoplanets.

youtube.com/newscientist

Newsletter

Health Check

Warmer weather and wetter conditions have extended mosquito season in many parts of the world, as well as bringing different species to new habitats. With them have come spikes in mosquito-borne illnesses. The good news, writes Grace Wade, is that we have the tools to protect ourselves.

newscientist.com/healthcheck

A note from the executive editor

Dear readers,

New Scientist Live is one of my favourite weekends each year, and so it is with great excitement that I can say it is now just over a month away. On 12 and 13 October, thousands of people will descend on the ExCeL Centre in London to attend what I think we can confidently call the greatest festival of ideas and discoveries in the known universe. Across five stages, we will have talks from exciting scientists and big thinkers, covering everything from black holes and brain health to the science of free will and the paranormal.

I can't wait to hear what Turi King has to say about how genetic testing is revolutionising genealogy and Carolyn Thompson's talk about the amazing lives of gibbons.

The show floor will also be filled with incredible experiences and exhibitions once again, including a virtual-reality rollercoaster, ocean artefacts, live insects, robots and even an aerobatic jet-powered aircraft from the Royal Air Force's Red Arrows.

Our schools' day on 14 October is a chance for thousands of students and their teachers to experience the show floor in full, as well as a specially tailored programme of talks.

If you can make any of the show days, you won't regret it. And if you can't, you can still catch the talks on demand with an online ticket. I hope to see you there.

Timothy Revell
New Scientist executive editor

It is rocket science, actually

Using a backup plan in space isn't a sign of failure, but of success

AFTER any problem with a rocket launch or mission, experts echo the same refrain: space is hard. As progress in the space industry accelerates, that mantra is becoming more relevant, not less, but that is because we are facing the difficulties of space flight more frequently – and, largely, overcoming them.

The situation unfolding on the International Space Station (ISS) over the past few months is a perfect example. Boeing's Starliner spacecraft launched for its first crewed flight on 5 June, but hardware issues meant that once it arrived at the ISS, it was unclear if it would be safe for the two NASA astronauts it carried to safely ride it back to Earth as planned.

So, after testing on the ground and much deliberation, NASA pivoted and announced that the astronauts would be extending their stay in space and coming home in February 2025 aboard a SpaceX Crew Dragon craft instead (see page 18). Thanks to the wise decision NASA made a decade ago to choose two companies to build capsules to shuttle astronauts

"The first ever civilian spacewalk may well be the most dangerous spacewalk of all time"

into space instead of just one, a potentially devastating issue became a mere inconvenience. We have known the whole time that space is hard, and preparation paid off.

Hopefully, intense preparation will also pay off for the crew of SpaceX's upcoming Polaris Dawn mission. If all goes well, it will include the first ever civilian spacewalk, which may well be the most dangerous spacewalk of all time (see page 8).

If the walk goes smoothly, it will be another big win for commercial space flight and for SpaceX in particular – not least because it will be the first test of the firm's new spacesuits. Ageing suits have been a looming problem for NASA and other space agencies for decades – those in use by NASA are the same ones astronauts wore in the 1980s, and they are long past their prime. A reliable new spacesuit that even civilians can wear comfortably, with improved mobility and temperature control, would be a huge win. It would make space just a little bit less hard. ▮

PUBLISHING & COMMERCIAL
Commercial and events director Adrian Newton

Display advertising
Tel +44 (0)203 615 6456 **Email** displayads@newscientist.com
Sales director Justin Viljoen
Senior account manager Hayley Drummond
Account manager Mila Gantcheva

Recruitment advertising
Tel +44 (0)203 615 6458 **Email** nssales@newscientist.com
Recruitment sales manager Viren Vadgama
Key account manager Deepak Wagjiani

New Scientist Events
Tel +44 (0)203 615 6554 **Email** live@newscientist.com
Sales director Jacqui McCarron
Sales manager Maureen Ignacio
Head of event production Martin Davies
Head of product management (Events, Courses & Commercial Projects) Henry Gomm
Marketing manager Emiley Partington
Events and projects executive Georgia Hill
Events team assistant Olivia Abbott

New Scientist Discovery Tours
Director Kevin Currie
Senior product manager Lara Paxton

Marketing & Data
Marketing director Jo Adams
Head of campaign marketing James Nicholson
Digital marketing manager Jonathan Schnaider
Campaign marketing coordinator Charlotte Weeks
Junior marketing designer Ruby Martin
Head of customer experience Emma Robinson
Engagement marketing manager Kelly Spillane
Head of CRM & audience data Rachael Dunderdale
Senior email marketing executive Natalie Valls
Email marketing executive Ffion Evans
Marketing executive Rhianne Gavigan
Junior analyst Hamied Fahim

Technology & Product
Head of strategy and product development Clarissa Agnew
Director of strategic programmes and technology Jennifer Chilton
Head of engineering Tom McQuillan
Senior developer and UX designer Amardeep Sian
Senior developers Maria Moreno Garrido, Piotr Walków
Lead digital designer and developer Dan Pudsey
Front end developer Damilola Aigoro
Junior front end developer Matthew Staines

Partnerships
Consultant editor Justin Mullins

NewScientist
Chief executive Roland Agambar
Chief operating officer Jonas Hermans
Chief financial officer Depak Patel
Chair Nina Wright
Executive assistant Lorraine Lodge

Finance & operations
Head of finance Charlotte Lion
Senior finance analyst Charlie Robinson
Finance analyst Milan Novakovic

Human resources
HR business partner Purnima Subramaniam

CONTACT US
newscientist.com/contact

General & media enquiries
UK 9 Derry Street, London, W8 5HY
Australia 58 Gipps Street, Collingwood, Victoria 3066
US 600 Fifth Avenue, 7th Floor, NY 10020

UK Newsstand
Marketforce UK Ltd
Email mfcommunications@futurenet.com

Syndication
Tribune Content Agency **Tel** +44 (0)20 7588 7588
Email tca-articlesales@tribpub.com

Subscriptions
newscientist.com/subscription
One year print subscription (51 issues) UK £270
Tel +44 (0)330 333 9470
Email subscriptions@newscientist.com
Post New Scientist, Rockwood House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH

© 2024 New Scientist Ltd, England. New Scientist is published weekly by New Scientist Ltd. ISSN 0262 4079. New Scientist (Online) ISSN 2059 5387. Registered at the Post Office as a newspaper and printed in England by Precision Colour Printing Ltd

recycle
When you have finished with this magazine please recycle it.

EDITORIAL
Editor Catherine de Lange
Executive editor Timothy Revell
Managing editor Penny Sarchet
Creative director Craig Mackie

News
News editor Jacob Aron
Assistant news editors Chris Simms, Alexandra Thompson, Sam Wong
Reporters (UK) Madeleine Cuff, Michael Le Page, Matthew Sparkes, Alex Wilkins, Carissa Wong
(Aus) Alice Klein, James Woodford

Digital
Head of audience Matt Hambly
Podcast editor Rowan Hooper
Head of editorial video David Stock
SEO and analytics manager Finn Grant
Social media manager Isabel Baldwin
Trainee video producer Obomate Briggs

Features
Head of features Daniel Cossins
Editors Abigail Beall, Kate Douglas, Alison George, Joshua Howgego, Thomas Lewton, Linda Rodriguez-McRobbie
Feature writer Graham Lawton

Culture and Community
Comment and culture editor Alison Flood
Senior culture editor Liz Else

Subeditors
Chief subeditor Eleanor Parsons
Bethan Ackerley, Tom Campbell, Tom Leslie, Jon White

Design
Art editor Ryan Wills
Joe Hetzel, Phoebe Watts

Picture desk
Picture editor Tim Boddy
Assistant picture editor Jenny Quiggin

Production
Production manager Joanne Keogh
Production coordinator Carl Latter

New Scientist US
US Publisher Tiffany O'Callaghan
US editor Chelsea Whyte
Editors Sophie Bushwick, Molly Glick
Subeditor Alexis Wnuk
Deputy audience editor Gerardo Bandera
Reporters Leah Crane, James Dinneen, Jeremy Hsu, Karmela Padavic-Callaghan, Christie Taylor, Grace Wade, Corryn Wetzel

Subscriptions

NewScientist

BIG SUMMER READS

...TINY PRICE TAG

Last chance to subscribe for just £10

Subscribe now for unlimited access to trusted, expert reporting across our website and app anytime, anywhere.

newscientist.com/summer

or call +44 (0) 330 333 9470, quoting 21453

Offer ends 10 September 2024. Digital subscriptions are £1 a week for 10 weeks. These are auto-renewing subscriptions and at the end of your trial period, your subscription will renew at a higher rate. In the unlikely event that you wish to cancel, you can do so within your trial period and no further payment will be taken. We also offer a 14-day cooling off period after the initial payment is made.

Scan me to sign up

News

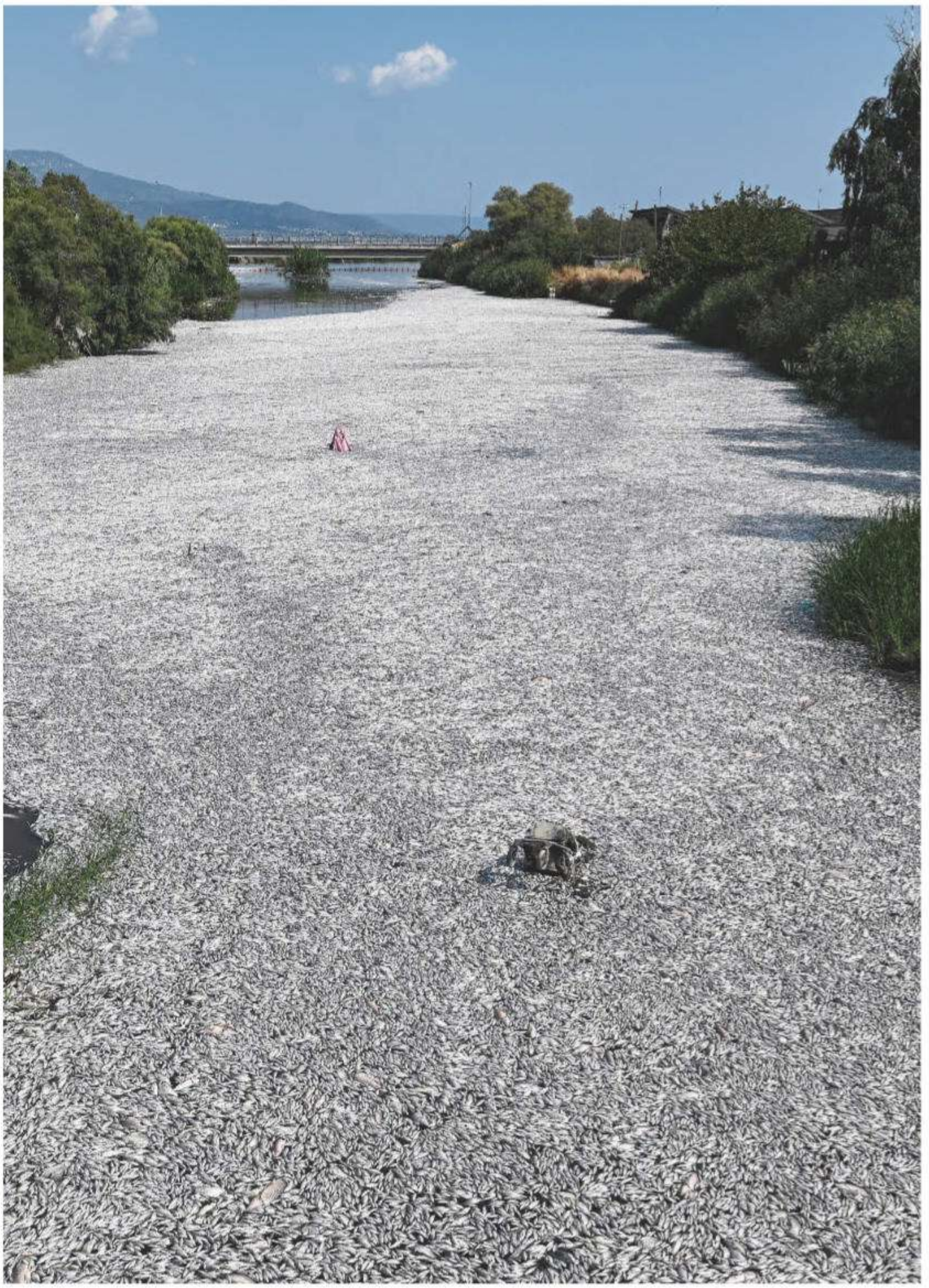
Shark vs shark
Large shark seems to have been eaten by a great white **p9**

Long-term risk
Can mpox cause lasting symptoms like long covid? **p12**

Dark dwarfs
Strange failed stars could hide dark matter inside **p13**

Light work
Laser tweezers may reveal quantum effects of gravity **p15**

Fungal fancies
Mould turns food waste into haute cuisine **p19**



SAKIS MITROLIDIS/AFP VIA GETTY IMAGES

Environment

River of the dead flows in Greece

Hundreds of thousands of dead fish have floated into the Pagasetic Gulf around the port city of Volos in Greece. The fish are thought to have originated in a nearby lake, which swelled hugely after floods last year. It has since shrunk, forcing the fish downriver and into the sea, killing them. Some 100 tonnes of dead fish have been removed since they began appearing in and around the city last week.

Space

Polaris Dawn crew prepare for riskiest spacewalk ever

Leah Crane

SPACEX is getting ready to perform the first civilian spacewalk. Until now, every time a human has left their spacecraft to venture into the void of space it has been a government-trained astronaut. But the Polaris Dawn mission – scheduled to launch during a window opening on 4 September as *New Scientist* went to press – is changing that, making it perhaps the most dangerous civilian space mission ever.

The main source of risk is that the Crew Dragon, which will carry four explorers into orbit, lacks an airlock. When astronauts on the International Space Station perform spacewalks, or extravehicular activities (EVAs), they don their suits and enter a sealed room. The air is then sucked out of that room before they head into open space, keeping the rest of the station sealed and full of air.

The Polaris Dawn crew members are due to spend up to five days in orbit. On the third day, the entire spacecraft will depressurise for about 2 hours, so even the two crew members who aren't leaving the capsule will have to wear specialised EVA suits. It isn't a new protocol – many of NASA's Gemini and Apollo spacecraft in the 1960s and 70s didn't have airlocks – but it is riskier than an EVA where the astronauts have a relatively safe airlock to retreat to in case of any issues.

"You're throwing away all the safety of your vehicle, right? And it now comes down to your suit, it becomes your spaceship," said mission commander Jared Isaacman during a 19 August press conference. Isaacman is the head of SpaceX's Polaris programme and its billionaire funder.

ZUMA PRESS, INC./ALAMY

The Polaris Dawn mission at Kennedy Space Center, Florida, ready for launch

Another source of risk is the spacesuits themselves, which are new. They have undergone extensive testing in vacuum chambers, but any new type of equipment tends to be more risky than one that has already been put through the wringer of space. There are other dangers too: the flight will travel further from Earth than any human has been since the end of the Apollo programme in 1972 and will have radiation and possibly micrometeorites to deal with.

"You're throwing away all the safety of your vehicle, right? And it now comes down to your suit"

Of the four crew members, only Isaacman has previously been to space. The other three are a retired test pilot, SpaceX's head astronaut trainer and one of SpaceX's lead space operations engineers. All three have worked in mission control for previous flights and have trained for this mission for two years.

"Even though these are not government astronauts, they are not space tourists – they are professionals," says Laura Forczyk, an independent consultant in the space industry. "I don't think you could come up with four better non-government astronauts for this mission."

So while the Polaris Dawn mission has many inherent dangers, the preparation of SpaceX and its astronauts should mitigate them. There is no such thing as a risk-free space mission, much less a risk-free spacewalk, but this is a crucial test for Crew Dragon and SpaceX's new EVA suits, plus the explorers will have nearly 40 science experiments to work on while they are up there.

"While every EVA is risky, I would not say this is extraordinarily risky," says Forczyk. "They have gone through every single scenario, they have backups and redundancies for every scenario, they are so well-prepared." ▮

Physics

Quantum holograms can send messages that disappear

Karmela Padavic-Callaghan

A QUANTUM disappearing act could make it possible to embed secure messages in holograms and selectively erase parts of them even after they have been sent.

Quantum light signals carrying information are inherently secure, as intercepting their messages destroys frail quantum states that encode them. To make use of this without bulky devices, Jensen Li at the University of Exeter in UK and his colleagues used a metasurface, a 2D material engineered to have special properties, to create quantum holograms.

The team encoded information into a quantum state of a particle of light, or a photon. They used a laser to make a crystal emit two photons that were inextricably linked via quantum entanglement. The photons travelled on separate paths, with only one encountering the metasurface. Thousands of tiny components on the metasurface, like nano-sized ridges, changed the photon's quantum state, encoding a holographic image into it.

The partner photon encountered a polarised filter, which controlled which parts of the hologram are revealed – and which disappear. The original photon's state was a superposition of holograms, so it simultaneously contained many possible variations of the message.

Because the photons were entangled, polarising the second one affected the image the first one created when hitting a camera. The test hologram contained the letters H, D, V and A, but adding a filter for horizontally polarised light erased the letter H from the final image.

Li says the metasurface could encode more complicated information into the photons, for example as part of a quantum cryptography protocol. He presented the work at the SPIE Optics + Photonics conference in San Diego on 21 August. ▮

Environment

Clothes made from potatoes could cut the fashion industry's environmental footprint

Madeleine Cuff

MAKING fabric from waste potato plants could offer a more sustainable alternative to pure cotton, as pressure grows on the fashion industry to reduce its environmental impact.

Potatoes pose a headache for farmers. The tubers are harvested and eaten, but the above-ground plant contains solanine, which is poisonous, so it can't be used for animal feed. Farmers usually pulverise or incinerate this matter before potatoes are harvested.

Now, UK start-up Fibe wants to avoid this waste by extracting fibres from potato stems to make a sustainable fabric. In April, it unveiled the world's first potato thread, a blend of 75 per cent cotton and 25 per cent potato fibres.

Fibe's co-founder, Idan Gal-Shohet, says it isn't yet producing enough fibres to make a potato-only yarn. A cotton blend also helps to create fabric with the right properties for commercial use, he says. "Our goal is to make fibres that retrofit into existing cotton-spinning machines."

The approach began as a project by a group of design engineering students, including Gal-Shohet, at Imperial College London. Tasked with designing a sustainable business concept, the group investigated using waste plants to create a more sustainable alternative to cotton. The students chose potato plants because they are produced at scale all over the world, are rich in fibres and their foliage has no other practical use.

Potato fibres can be made into soft balls that resemble cotton

FIBE

They turned their idea into a business after graduating in 2022.

Potatoes are the third most important staple food crop in the world but create about 150 million tonnes of waste plant matter per year. Fibe has developed a new way to extract the fibres, primarily using a biological process, says Gal-Shohet. "We are controlling the biodegradation process, in a way that yields us fibres."

Once raw fibres are extracted, they are cleaned and graded to produce soft balls. The potato fibres are similar in quality to cotton, says Gal-Shohet. However, because the land is already being used to grow potatoes, potato fibres require 99.7 per cent less water and emit 82 per cent fewer carbon emissions, as well as needing no additional land, according to Fibe's internal analysis.

Fibe's process could also be used to extract fibres from other plants, says Gal-Shohet, and the team is testing with peas and hemp.

To date, the firm has received almost £2 million in investment and grant funding, including from Tin Shed Ventures, the venture capital arm of clothing brand Patagonia. In July, it was awarded £15,000 in prize money by Fashion District, a London-based fashion collective.

Gal-Shohet says Fibe is in the final stages of agreeing a deal with a well-known brand to jointly develop commercial potato fabric. The firm aims to build a pilot production plant in the UK in 2025, with products available from 2026.

Muhammad Tausif at the University of Leeds, UK, who has worked with Fibe, says industry demand for sustainable fibres is growing, but the company will need to prove its potato fibres have the "length, fineness and strength" to compete with cotton. "For a fibre to be successful [and] to be made into a product, these are the key parameters," he says.

Cost is also a crucial factor. Tausif says a low starting price will be important to entice brands to place big orders. Gal-Shohet says Fibe yarn will initially be more expensive than cotton because production will be at a small scale, but price parity will be possible once production scales up. ▮

Marine biology

Pregnant shark may have been eaten by another shark

A PORBEAGLE shark may have been eaten by a great white, in the first recorded incident of its kind.

In October 2020, Brooke Anderson, then at Arizona State University, and her colleagues tagged a pregnant porbeagle shark (*Lamna nasus*) south-east of Cape Cod in Massachusetts as part of research into shark migration.

The researchers used a pop-off tag, which continuously measures the depth and temperature. If the tag detaches from the shark and floats to the surface, the stored data is pinged back to shore.

Five months after the shark was tagged, the tag resurfaced south-west of Bermuda and sent data on its recent movements.

The shark had spent five months cruising through waters at a depth of 600 to 800 metres during the day and 100 to 200 metres at night, with water temperatures varying from 6.4 to 23.5°C (43.5 to 74.3°F), according to the tracker.

But from 24 March 2021, something changed. The ambient temperature around the tag was between 16.4°C and 24.7°C (61.5°F and 76.5°F), despite it being at a similar depth to before. There was also a shift in diving patterns (*Frontiers in Marine Science*, DOI: 10.3389/fmars.2024.1406973).

It suggests the tag and the shark were eaten, says Anderson, who now works at North Carolina Division of Marine Fisheries. "All our evidence points to the same conclusion," she says. "That our porbeagle shark was eaten by another shark."

"This was a big female shark that got eaten, so something larger than it probably attacked it"

A great white shark (*Carcharodon carcharias*) is the most likely culprit, the team concluded, as it is the only predator in the area large enough to mount such an attack. The diving patterns and body temperature of a great white also match the tag data.

"This was a big female shark that got eaten," says team member James Sulikowski at Oregon State University. "So something probably larger than it had to have attacked it." ▮

Madeleine Cuff

New Scientist Live
Signals from the beginning of the universe
Join Jo Dunkley's quest to fathom the Big Bang on 13 October
newscientist.com/nslmag

Astrophysics

'Impossible' galaxies probed

We may now know what makes very distant "little red dot" galaxies appear much more dense than other galaxies we have seen, finds **Alex Wilkins**

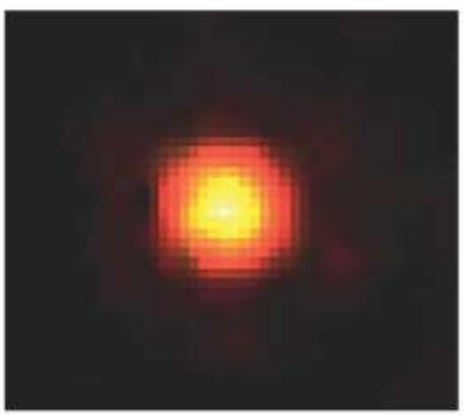
STRANGELY bright galaxies spotted by the James Webb Space Telescope (JWST), called "little red dots", may have more stars packed into them than any other galaxies we know of. The density appears so high that it is unclear how the stars even survive without crashing into their neighbours.

Shortly after JWST started searching the very distant and early universe in 2022, astronomers started to see extremely bright and red, but apparently tiny, galaxies, which they called little red dots (LRDs).

Their brightness had two obvious, yet problematic, explanations. Either it came from supermassive black holes that were so large they would have had to form very fast, close to the start of the universe, or it came from the stars themselves, which would require huge masses of stars that were also difficult to explain.

There were further puzzles for astronomers. When they analysed the light, it had some features of what supermassive black holes look like, such as a broad spectrum of different frequencies, but it was missing other key features seen with black holes, such as X-rays and radio waves. There were also other signs, such as a peak in the light's brightness at certain frequencies, that suggested it came from stars. It was difficult to distinguish between the two scenarios for these far-off galaxies, in part because astronomers lacked accurate properties for them, such as their size.

Now, Josephine Baggen at Yale University and her colleagues have used JWST data to calculate the properties of three LRD galaxies, including their size. The results show that these galaxies are so small that if the light they produce is coming from stars, the stars must be impossibly tightly packed (arXiv, doi.org/nfg7).



JOSEPHINE F.W. BAGGEN ET AL. (2024)

"The galaxies are so compact, it was kind of a shock the first time we measured these sizes"

"They're so compact, it was kind of a shock the first time we measured these sizes," says Baggen. "They're about 100 times smaller than a typical galaxy that we see today, like the Milky Way, but it's possible that they have the same stellar mass. That's a big issue," says Baggen.

They also found further evidence that suggests this light was coming, at least in part, from stars. Using the galaxies' size and mass, Baggen and her team then calculated how fast these stars were moving and found that, on average, they were travelling about 10 times as fast as stars in regular galaxies. This speed might be enough to account for the broad-frequency radiation that astronomers see from the LRDs but that is normally associated with black holes, says Baggen.

"This is now a very self-consistent story," says Baggen. "We don't see X-ray; we don't see radio; the broad lines are simply explained by the size and the stellar mass. Everything works, but the densities are just so high that we still need to understand how that happened. I like this story a lot, but it requires more evidence."

It is an intriguing hypothesis, says Andy Bunker at the University of Oxford, and there is a way to test it. An instrument on JWST, which measures a different, less red part of the light spectrum, can measure these star velocities more directly, which could tell us whether we really are seeing stars, he says.

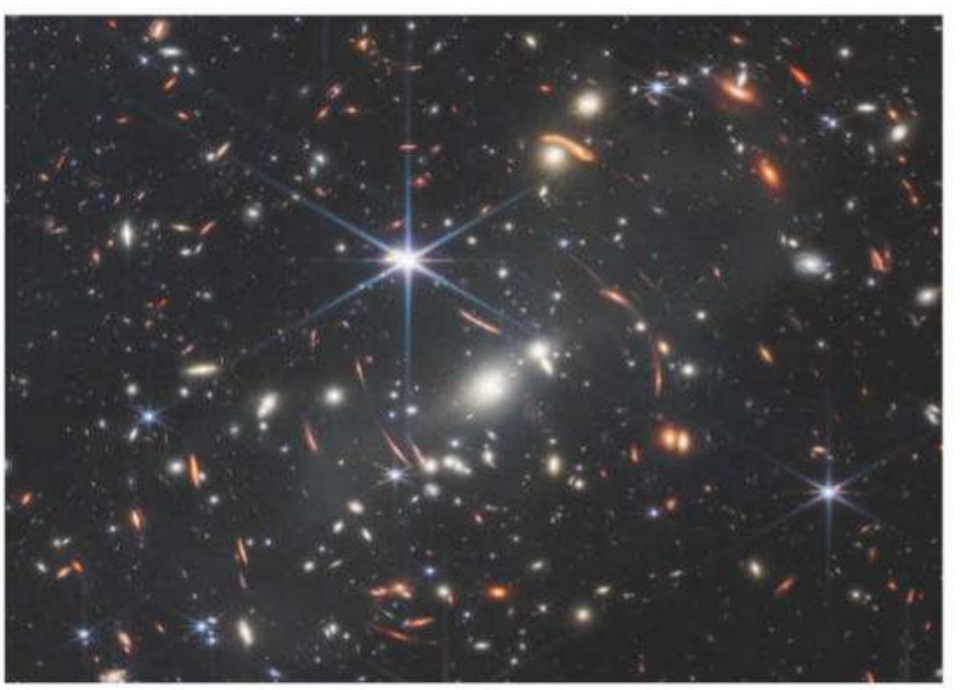
In a separate study, Fabio Pacucci at the Harvard-Smithsonian Center for Astrophysics and his colleagues looked at the densities for a larger sample of about 500 LRD galaxies, although with less detailed data on each one than Baggen and her team, and also found impossibly high stellar densities (*Research Notes of the AAS*, doi.org/nfg8). "It's possible that we are overestimating the stellar masses, but if they are real, it's a serious problem for astronomy," says Pacucci.

Defying explanation

The fate of these galaxies is a further conundrum. It is unclear whether star densities this high are even possible inside a galaxy without stars colliding and eventually forming a black hole, says Pacucci. But if they do form large black holes, like quasars, then it doesn't match how many quasars we see in the early universe.

If the stars can avoid coalescing into a black hole and instead evolve into a regular galaxy, then they should become less dense, says Baggen, but there aren't good physical explanations for how this might happen, or what they might look like. "Nobody really understands what they are evolving into. It's such a weird population," says Pacucci.

Another issue is that although the LRD galaxies appear similarly bright, red and small, they could actually be a mix of black hole-dominated and star-dominated galaxies, says Sandro Tacchella at the University of Cambridge. This could make their apparently extreme properties easier to explain because it would better match the diversity of galaxies we see in our local universe, which would be like the LRD's descendants. ▮



NASA, ESA, CSA, AND STSCI

Top: a JWST image of a little red dot galaxy. Right: a larger view of distant galaxies captured by JWST, in which red dot galaxies have been spotted

Zoology

Marmosets are first non-human primate found that seem to call each other by name

Sofia Quaglia

MARMOSETS use unique calls for other monkeys in their groups, much as humans call each other by name. They are the first non-human primates known to do so and the discovery could help teach us how human language evolved.

"Up till quite recently, people thought that human language is a singularity phenomenon that popped out of nothing," says David Omer at the Hebrew University of Jerusalem in Israel. "We're starting to see evidence that this is not the case."

Marmosets (*Callithrix jacchus*) live in monogamous family groups and spend their lives in dense rainforest canopies, so use high-pitched melodies that carry through foliage to communicate.

Omer and his colleagues have now analysed these high-pitched "phee calls" in the lab, recording exchanges between pairs of marmosets separated by a screen. They paired up 10 marmosets from three families in a variety of combinations, then used artificial intelligence to sort more than 50,000 calls they made into different categories according to subtle acoustic differences. Later, they observed how three of those marmosets reacted to the lab recordings of phee calls both directed at them and at others.

The team found that marmosets make 16 types of subtle acoustic tweaks to the phee calls depending on which monkey they are addressing. They intersperse monkey-specific modulations throughout the call – in human language, it may be akin to interjecting a friend's name throughout a sentence.

Marmosets respond faster and more reliably to calls that are directed to them than they do to ones aimed at others, meaning they understand they are being called on, says Omer.

The analysis also suggests that family members use similar identifying labels for the same monkey as if it were a designation distinct to them, like a personal name (*Science*, doi.org/nfcj).

If marmosets do use unique personalised names, they would have to be learning how to make the specific sounds the names entail, says Daniel Yasumasa Takahashi at the Federal University of Rio Grande do Norte in Brazil. This implies marmosets have a more flexible vocal system than previously thought, he says.

The findings also pose the question of whether marmosets can vocally label other objects – and because naming people, places and objects is a fundamental property of language, it could help us pinpoint when that began to evolve.

A growing body of studies suggests that a variety of animals call each other with identifiers, including a few species of parrot, bottlenose dolphins and African savannah elephants. This suggests name-calling has cropped up independently across the tree of life, says Michael Pardo at Colorado State University.

"Many animals are a lot more cognitively sophisticated and have much richer social lives than has historically been recognised," he says. ▮

DAVID OMER LAB

A mother-daughter pair of marmosets whose calls were studied

Physics

Weird tunnelling could charge up quantum batteries

EXTREMELY cold atoms tunnelling through a crystal made using light could create a stable quantum battery. This could solve a long-standing leakage issue with such batteries and help them offer an advantage over conventional ones.

Quantum batteries extract energy from quantum processes, such as those involved in moving particles. As yet, there is no consensus on a best design for them.

Bruno Juliá-Díaz at the University of Barcelona in Spain and his colleagues have come up with a proposal for a quantum battery using ultracold atoms and lasers.

Ultracold atoms are both very susceptible to quantum effects and can be precisely controlled by the electromagnetic forces of laser light, so we can use lasers to arrange them into crystal-like lattices.

Juliá-Díaz and his team propose orienting lasers so there are only three positions available to the atoms, each with a higher energy than the previous one.

The three potential-energy wells constitute the battery, and for it to be fully charged, all atoms have to be in the highest well. Because of the atoms' quantum properties, they don't remain stuck in the wells, but can tunnel from one to the next.

However, the researchers have devised a sequence of pulses of electromagnetic radiation to control how many atoms tunnel between any two wells. This would make all the atoms end up in the most energetic well but not allow them to tunnel back down the energy ladder, because the quantum states they would have to assume to do so would be prohibited by the electromagnetic forces. The researchers' calculations show a stable way to charge the quantum battery and keep it charged (*Physical Review A*, in press).

"A sequence of pulses of electromagnetic radiation controls how many atoms tunnel between two wells"

"Stability is the key point here," says Steve Campbell at University College Dublin in Ireland. "The work really takes a candidate setting for a quantum battery and brings it closer to a meaningful realisation." ▮

Karmela Padavic-Callaghan

New Scientist Live
Why we age and die
Venki Ramakrishnan on the science of longevity
newscientist.com/nslmag

Health

Does mpox cause lasting symptoms?

As mpox cases rise, it is important to uncover whether this virus, like the coronavirus, causes symptoms even after the infection has cleared, finds **Carissa Wong**

CASES of mpox are surging in the Democratic Republic of the Congo and several of its neighbouring countries. The DRC alone has reported more than 15,000 cases and 500 deaths, already exceeding its 2023 total, which itself was a record. Cases have also been detected in four countries outside Africa. Other infections can cause lingering complications, such as long covid, which can occur even after mild bouts of covid-19. So, is this a risk with mpox?

Mpox, formerly known as monkeypox, commonly causes a rash that develops into blisters, as well as aches, pain, fever and fatigue, which usually begin within a week of infection and last for two to four weeks. A great deal of research has been done into conditions like long covid, of which there have been an estimated 1.9 million cases in the UK alone, but few scientists have studied mpox's lasting effects.

Efforts were made amid the 2022 mpox outbreak, when it was first declared a global public health emergency, as cases spread on continents like Europe and North America for the first time. But that variant of the virus, called clade IIb, is different to the one driving the current emergency, clade Ib, which was only identified in September 2023, so there are no long-term studies into its effects.

Jean Claude Udahemuka at the University of Rwanda has been studying the situation since March. So far, any lingering symptoms seem to be temporary. Complaints of fatigue and pain stop within a couple of weeks, he says. But Udahemuka is only following 200 people and, given the extent of mpox's spread, we can't rule out others being more badly affected.

TOP: AP PHOTO/FAREED KHAN/ALAMY; BELOW: CDC/ASSOCIATED PRESS/ALAMY

An isolation ward in Karachi set up after an mpox case was detected in Pakistan

For instance, post-viral fatigue, when the lethargy that starts during an infection continues after it has gone, is among the most common symptoms of long covid, sometimes persisting for years. There is no reason to think mpox should be different, according to Udahemuka and Christophe Van Dijck at the Institute of Tropical Medicine in Antwerp, Belgium.

>15,000
Mpox cases in the Democratic Republic of the Congo in 2024

>500
people have already died from mpox in the DRC this year

Mpox commonly causes lesions that can blister and scar

As clade Ib research is limited, some scientists are looking at clade IIb for clues. The similarities between the two variants' initial symptoms suggest that any prolonged effects would also be similar, says Van Dijck.

He and his colleagues have followed 119 people in Antwerp after they caught mpox in 2022. The results, which haven't yet been published, suggest that about a fifth of them had fatigue before they got mpox, which increased to a quarter eight months after the infection and only returned to pre-infection levels by 16 months later.

Scarring also seems common with clade IIb, but the proportion of people this affects varies hugely from study to study, from just over 10 per cent to more than 80 per cent. This is probably due to the small numbers of people in these studies, as well as differences in their ages and overall health, says Van Dijck. In his study of 119 people in Antwerp, 14 per cent had scars on their face, hands or genitals just over a year after infection.

That may be one of the reasons why symptoms of anxiety and depression can also occur after mpox, says Charlie Witzel at University College London. "People report that they are conscious of having their scars and they are consciously changing their clothing or finding ways to hide the scars," says Van Dijck, whose team found that symptoms of anxiety and depression rose by about 7 per cent in the eight months after an infection, but didn't persist for much longer.

Mpox may also cause these symptoms by directly affecting the brain, says Witzel. Emerging evidence suggests the virus affects the central nervous system, with reports of confusion and memory loss, on top of common symptoms like headaches. "The virus has been isolated in different types of samples – semen, breast milk and so on," says Udahemuka. "So, probably it can also reach that part of the body."

Stigma's role

Not everyone is convinced. "Mpox seems to have very limited impact on the brain," says Van Dijck. Brain swelling, for example, is rare, he says. Lingering mental health symptoms could simply be the result of people isolating or stigma associated with mpox, says Witzel.

These results help point us in the right direction, but only time will tell if clade Ib has lasting complications – or even more serious ones than we have seen with mpox before. Clade I is more dangerous than clade II and "generally, the more severe an illness is, the more severe the long-term issues", says Witzel. ▮

Astrophysics

Failed 'dark dwarf' stars could hide dark matter inside them

Alex Wilkins

DARK matter-fuelled brown dwarfs could lurk at the centres of galaxies. If we spot them, they could teach us how dark matter interacts with regular matter.

Brown dwarfs are vast balls of gas, between 13 and 72 times as massive as Jupiter but smaller than stars and with too little matter to sustain the nuclear fusion of hydrogen. The threshold at which they start fusing hydrogen and become stars, known as the hydrogen burning limit, is around 0.075 times the mass of our sun.

Djuna Croon at Durham University, UK, and her colleagues have now found that this limit might be higher if the brown dwarfs have dark matter annihilating inside them. According to calculations by Croon and her team, this extra energy would make the brown dwarf expand and cool slightly.

To calculate the properties of these objects, which the researchers call "dark dwarfs", they came up with an equation that relates the dark dwarf's internal pressure to how much energy it has. From this, they could then work out how features, such as size and temperature, change and compare them with regular brown dwarfs.

Unlike regular brown dwarfs, which tend to get cooler and aren't bright enough to easily spot, Croon and her team found that dark dwarfs should remain relatively bright for longer (arXiv, doi.org/nfgs). They may also be identifiable through elevated levels of lithium – because dark dwarfs would also be cooler than brown dwarfs, they wouldn't be able to burn as much of the element.

Such dark dwarfs would require a high concentration of dark matter, which is thought to occur near the centre of galaxies, says Croon. If we spot them, it could tell us about how often dark matter interacts with normal matter, she says. ▮

Technology

Why is the US military preparing to launch new spy balloons?

Jeremy Hsu

THE US military is planning to deploy balloons capable of providing high-altitude surveillance. It comes after the nation scrambled fighter jets to shoot down a Chinese balloon as it drifted through North American airspace last year.

Modern balloons can use artificial intelligence to predict and ride wind currents while operating at altitudes of about 18 kilometres, or even higher, in Earth's stratosphere for commercial and military purposes. Those heights make them hard to track and engage while also requiring expensive air-to-air missiles to shoot them down, says Lawrence Stutzriem at the Mitchell Institute for Aerospace Studies, a think tank in Washington DC.

Now, the US military has fast-tracked the development and deployment of such high-altitude surveillance balloons through its Rapid Defense Experimentation Reserve programme, according to news site *Breaking Defense*.

Soldiers from the US and the Philippines with a high-altitude balloon in June

U.S. ARMY/PUBLIC DOMAIN

Heidi Shyu, chief technology officer at the US Department of Defense, told the publication that the army and air force are interested in deploying such balloons after seeing initial demonstrations by the programme.

These balloons are cheaper and more disposable than crewed aircraft, drones or satellites. They also offer a backup option in case an adversary disrupts US military space satellites through jamming, spoofing or hacking, says Stutzriem, and have their own specific benefits.

"While satellite constellations provide incredible capability, a high-altitude balloon positioned directly over an area of interest is maybe 10 times closer to the surface of the Earth, thereby providing significantly better resolution or detection sensitivity," he says.

The push for balloons comes after the US shot down a Chinese balloon that drifted across North America in early 2023. US government officials described the wreckage as having included surveillance equipment, which the Chinese government denied, describing it as a weather balloon.

A swarm of more than 100 Chinese balloons also flew near and over Taiwan around the time of its presidential elections in late 2023 and early 2024. China claims self-governing Taiwan as its own territory and has regularly deployed military aircraft and warships nearby.

"Balloons can provide better resolution or detection sensitivity than satellites"

Meanwhile, the US Army launched high-altitude balloons from Guam and the Philippines during military exercises with US allies in the Pacific in June. The military service has also been looking for radar and communications sensors weighing less than 7 kilograms that can be carried by high-altitude balloons, according to an army notice published in July.

A separate army notice in August describes an ongoing effort to develop and demonstrate a balloon-borne version of lidar, a sensor technology that uses laser pulses to create 3D digital maps of environments.

US military interest in balloons goes back to before the 2023 incident, says Stutzriem, who says "the lack of capacity and capabilities to operate in a highly contested fight against China" has "accelerated thinking in that direction".

"High-altitude balloons fill some very important gaps in capability due to the rise of peer adversaries in this new era of great power competition," he says. ▮

Health

Mosquito-borne illnesses are spiking around the world

Grace Wade

A RARE virus spread by mosquitoes has killed one person in the US. The death, announced on 27 August, occurred in New Hampshire and is the state's first known case of the virus since 2014. Massachusetts, New Jersey, Vermont and Wisconsin have each reported a case as well. The situation has become so concerning that some towns have closed parks after dusk – peak mosquito-biting hours – and restricted outdoor activities and public events.

Eastern equine encephalitis, which has a 30 per cent mortality rate, is endemic to the US. Yet outbreaks have become more frequent in recent years, largely due to climate change, says Catherine Brown at the Massachusetts Department of Public Health. While Massachusetts usually sees outbreaks every 10 to 20 years, only four years have passed since the last one ended.

Warmer weather in spring and autumn and wetter conditions have allowed mosquitoes to emerge earlier and survive later into the year, giving them a longer period in which to transmit disease, says Sadie Ryan at the University of Florida.

Between 1979 and 2022, annual mosquito days – when weather conditions are suitable for the pests – have increased by more than two weeks across much of the US. A warming climate also expands the insects' geographic range. As a result, mosquito-borne illnesses are spiking around the world.

For instance, Brazil has seen an increase of more than 800 per cent from last year in cases of Oropouche virus, which causes symptoms similar to dengue or Zika virus. Across five South American countries, there have been more than 8000 cases – these include two deaths, the first ever known to be caused by the virus.

NEW YORK TIMES/REDUX/EYEVINE

Forges Field in Plymouth, Massachusetts, has been closed at night

This year is already the worst on record for dengue, as well. As of July, more than 11 million cases of the virus, including more than 7000 deaths, have been reported worldwide. That is almost double the historically high number of cases seen in 2023.

Dengue cases have been trending upwards for years now. For instance, there were about 170 cases of locally acquired dengue in the continental US in 2023, roughly equivalent to the total number of cases between 2014 and 2022. Europe has seen a similar trend. Only 73 locally acquired cases occurred on the continent between 2010 and 2021, but 2022 and 2023 saw a decade's worth or more of cases in a single year.

This is partly due to the expanding range of mosquito species that can transmit dengue, such as *Aedes albopictus*. European regions with established populations of this species more than doubled between 2013 and 2023. "If we think about the sweet spot for transmission in terms of things like temperature and sufficient rainfall, as those shift poleward, you have more opportunities for [mosquito] introduction into new places," says Ryan.

Massachusetts began aerial spraying a pesticide called Anvil 10+10 this week to control the eastern equine encephalitis outbreak. However, the simplest measures can sometimes be the most effective, says Ryan. This includes installing screens on windows and doors, emptying outdoor containers with stagnant water and wearing protective clothing. "Those basic, household-level protective measures can be a genuine game changer," she says. ▮

800%

Increase in Oropouche virus cases in Brazil since last year

Geology

We may finally know how massive gold nuggets form

James Woodford

EARTHQUAKES may cause gold nuggets to form in quartz by generating an electric field that attracts gold dissolved in fluid forced up from deep underground.

Enormous gold nuggets are often associated with quartz, a ubiquitous yet chemically inert mineral, but until now no one could explain how such valuable lumps of metal were formed. "The mystery has been how do you make a large gold nugget in a single spot when there's no obvious chemical or physical trap," says Chris Voisey at Monash University in Melbourne.

The secret is in the structure of the quartz, says Voisey. Quartz crystals lack a centre of symmetry. This means that when they are subjected to pressure by an earthquake's seismic activity, their internal electromagnetic configuration is altered and they produce electricity. Gold-bearing hydrothermal fluids from Earth's mid to lower crust, 15 to 20 kilometres down, are driven up through fissures during seismic activity.

Voisey and his colleagues hypothesised that the dilute gold in this fluid is concentrated into nuggets within veins by the electricity of the quartz during repeated earthquakes. To test this idea, they conducted experiments with quartz crystals placed in a solution containing gold.

Quartz samples that weren't subjected to pressure didn't attract gold, but those that were generated a voltage and attracted the metal (*Nature Geoscience*, DOI: 10.1038/s41561-024-01514-1). Once gold started depositing on the quartz, it rapidly attracted more, says Voisey. "Because gold is a conductor, there's a preferential bias for gold in solution to deposit on pre-existing gold," he says. "It becomes like a lightning rod that attracts more gold." ▮

New Scientist Live
Signals from the start of the universe
See Jo Dunkley outline our quest to understand the cosmos
newscientist.com/nslmag

Physics

Laser tweezers could reveal if Einstein's ideas of gravity work in the quantum realm

Karmela Padavic-Callaghan

THE way gravity affects the quantum world is a mystery. But an experiment that uses tweezers made of light could be the first to let us assess how it really works.

At cold temperatures of just billionths of a degree above absolute zero, quantum effects make atoms behave like "matter waves" rather than particles. Physicists have long taken advantage of this. By colliding different matter waves and measuring the resulting ripples, they can identify the forces influencing the atoms, a process called atom interferometry.

Now, Yoav Sagi and Ilan Meltzer at the Technion-Israel Institute of Technology have come up with an interferometry experiment that could determine how Albert Einstein's ideas about gravity work in the quantum realm. If gravity can change a quantum state, there could be far-reaching implications. For example, it might help explain why a quantum particle can exist in

SHUTTERSTOCK/SAKKMESTERKE

Beams of light are very useful in quantum experiments

multiple places at once, a state called superposition, but a large and heavy object cannot.

The test relies on controlling the position of a single, ultracold atom of ytterbium with lasers, holding it in place as if it were clamped with tweezers.

Because the cold atom is behaving like a wave, it can exist in a superposition. By placing a second set of laser tweezers near the first, the atom-wave could end up existing in two states, with the atom located in both tweezers at the same time. The researchers would then separate the tweezers by a few millimetres and bring them together again. The recombination would cause the two parts of the superposition state to clash, producing ripples like in any interferometry experiment (*Physical Review A*, in press).

This would all be done with the atom also acting as an atomic clock, because another laser is pushing electrons within it to rapidly oscillate between two quantum states, with each oscillation acting like the tick of a clock. This would make the experiment sensitive to anything odd that may happen to time, like gravity slowing it down, says Sagi.

Einstein's general theory of relativity predicts such an effect, asserting that time slows down in areas that experience a stronger gravitational pull. For example, a clock at sea level runs slightly slower than one on top of a mountain, and thus further from Earth's gravitational influence.

Having one set of laser tweezers higher than the other would separate the atom's quantum states vertically so they would experience different pulls of gravity, so the atom-turned-clock in one set of tweezers should tick very slightly more slowly than the other. If the researchers see signatures of this effect after bringing the tweezers together, it would indicate that gravity changes the states of quantum objects.

Hendrik Ulbricht at the University of Southampton, UK, says no experiment has yet been sensitive enough to definitively determine how

"The atom's vertically separated quantum states would experience different pulls of gravity"

gravity changes the atom's quantum state or the way it experiences time, but the optical tweezers could help.

Sagi is confident that they will. "I'm not by any means claiming that this experiment will be easy, but we propose something which is at least possible to do with current technology," he says. ▮

See page 32 for more on the quantum realm

Technology

World's largest sailing cargo ship crosses the Atlantic

THE largest sailing cargo ship in the world has made its maiden voyage across the Atlantic Ocean. It left France in early August and was on track to deliver 1000 tonnes of cognac and champagne to New York City as *New Scientist* went to press. Its shipments have a carbon footprint one-tenth that of a standard container ship.

"For centuries, we knew wind was abundant [over] the deep sea," says Guillaume Le Grand, CEO of TOWT, the French company that commissioned the 81-metre-long ship, named Anemos. "But now, thanks to satellite communication and routing technology, wind is also predictable, which makes it a reliable source of propulsion."

Anemos's cloth sails are deployed and handled using an automated system, designed using computer simulations. This enables Anemos to transport 1 tonne of cargo over a kilometre while producing less than 2 grams of carbon emissions. The huge container ships that transport most of the world's goods emit at least 20 g per tonne over 1 km.

Although Anemos primarily relies on wind power, as a backup, it has two diesel-electric engines. It is part of a planned fleet of eight ships.

TOWT

The deployment of sails on the cargo ship Anemos is automated

The full impact of ships that use wind-assisted propulsion remains difficult to quantify. According to a report last month from UK-based maritime services company Lloyd's Register, there is "uncertainty around actual fuel savings, with no standardised criteria for validating savings claims". Potentially hidden costs of engineering work and operations also contribute to uncertainty, says the report.

The development of the sailing cargo vessel sector can help the shipping industry towards its net-zero emissions goals, says Gavin Allwright at the International Windship Association, a non-profit organisation based in the UK. ▮

Jeremy Hsu

New Scientist Live
A talk on the wild side
Hear wildlife presenter Chantelle Lindsay on 12 October newscientist.com/nslmag

Zoology

World's fastest backflip

Springtails spin at up to 368 rotations per second to avoid danger

Carolyn Wilke

HIGH-speed cameras have captured in vivid detail how springtails flip themselves into the air, showing that they spin faster than any animal ever recorded.

Springtails, a type of arthropod, are millimetres long and found in most places on Earth. To evade predators, the animals use a tail-like appendage called a furca, which folds beneath their bodies, to spring off the ground.

Jacob Harrison at the Georgia Institute of Technology in Atlanta and Adrian Smith at North Carolina State University have filmed dozens of *Dicyrtomina minuta* springtail vaults. Each jump flung the minuscule acrobats some 60 to 80 body lengths away on an arcing, backwards trajectory. The rate of their spinning surpassed all other animals that have been studied – up to 368 rotations per second (*Integrative Organismal Biology*, doi.org/nd94). ▮

ADRIAN SMITH

Physics

How ice forms in the scorching interiors of planets

COMPRESSING super-hot liquids between diamonds has demystified how fluids behave under extreme conditions, such as in the interiors of planets.

Physicists have struggled to track how a liquid's density changes at extreme temperatures and pressures. To address this, John Proctor at the University of Salford, UK, and his colleagues have compressed several liquids including water, methane and ethane in a millimetre-sized chamber.

They did this by heating each liquid up to 240°C (465°F) and sandwiching it between two tiny diamonds. This created pressures up to about 120,000 times greater than that of the atmosphere.

Proctor and his colleagues found that even extremely hot water could become an ice crystal when the pressure was high enough. Extreme pressure forced the water's atoms to bond and form a solid. In separate experiments, the team saw the same happen to methane and ethane. Proctor says this could offer insights into the behaviour of pockets of water trapped deep underground, where they can influence seismic activity.

To determine the density of these extra-hot, extra-compressed liquids, the researchers beamed a laser into the chamber. They could then infer each liquid's density from the way light bent as it travelled through (*Physics of Fluids*, doi.org/nd9k).

"This is a hundred-fold increase of what we can do in terms of our understanding of density versus pressure [for fluids]," says Proctor.

"This could offer insights into the behaviour of pockets of water trapped deep underground"

Matthew McCluskey at Washington State University says that while researchers have a good grasp on how to study solids under extreme pressures and temperatures, there is a gap in experimental techniques and mathematical theories when it comes to studying liquids as common as water. The new experiment fulfils a very real need for measurements of liquids' properties that can then be used in other experiments, he says.

In the future, Proctor and his colleagues want to get even closer to emulating the insides of planets like Jupiter and Saturn by filling their chamber with liquid hydrogen. To make things more realistic, they would also have to increase the pressure up to hundreds of times higher. "That is the dream," says Proctor. ▮

Karmela Padavic-Callaghan

Environment

Simple driving trick could slash car carbon emissions

Jeremy Hsu

SPEEDING up to junctions and then slamming on the brakes generates significant carbon emissions, which could be cut by programming cars to glide up to intersections instead.

To estimate potential emissions reductions from altering how people drive, Vindula Jayawardana at the Massachusetts Institute of Technology and his colleagues modelled vehicle behaviour at more than 6000 intersections in three major US cities: San Francisco, Los Angeles and Atlanta, Georgia.

The model accounted for varying traffic and environmental conditions, such as lane configurations and weather, and simulated nearly 1 million scenarios. The researchers then trained artificial intelligence agents to figure out what would most reduce carbon emissions and travel time. They found that gliding towards intersections and limiting idling time while waiting at them was most effective.

The model suggests that if every gas or diesel-powered vehicle in the US followed these two practices, it could cut the country's yearly carbon emissions by between 62 million and 123 million tonnes (arXiv, doi.org/nd6c).

Even if just 10 per cent of US vehicles adopt these behaviours, it could still drive up to half of the possible emissions reductions. This is because these vehicles would influence the behaviour of vehicles behind them, says Jayawardana.

The study also showed that nearly 70 per cent of emissions reductions came from just 20 per cent of intersections, hinting that rethinking the set-up of some junctions would also cut emissions.

Eco-driving could offer important emissions benefits and help smooth out traffic, but more work is needed to work out how to do it best, says Chris Hendrickson at Carnegie Mellon University in Pennsylvania. ▮

Technology

Vaporising process could recycle plastic bags and bottles indefinitely

Matthew Sparkes

PLASTIC bottles and bags can be vaporised into chemical building blocks and turned into new plastics with all the properties of virgin material. There are hurdles still to overcome, but the new process is a big step towards a truly circular economy for plastic.

About 5 billion tonnes of plastic has gone to landfill since the 1950s, and recycling efforts have only tackled 9 per cent of what we have produced. With current techniques, plastics degrade in each recycling round and end up in landfill after only a few cycles of the process.

John Hartwig at the University of California, Berkeley, and his colleagues had previously developed a method that breaks down waste plastic into its constituent parts, but it relied on the expensive metal catalysts iridium, ruthenium and palladium, which were irrecoverably lost as part of the process.

Hartwig says that the method was sufficient for a proof of concept, but nowhere near what would be needed for a cheap industrial process.

Now, his team has discovered an improved process that works on both polyethylene, from which most plastic bags are made, and polypropylene, which is used to make harder objects. And it relies only on catalysts considered so common that they are essentially "dirt", says Hartwig.

Plastics consist of large molecules called polymers, which are made up of smaller units called monomers bonded together. The catalysts break the chemical bonds of polymers, turning them into gaseous monomers from which new plastics can be pieced together with the properties of material that has never been recycled.

~90%

of a mix of plastics was turned into compounds that can be reused

In experiments, the team used two catalysts, sodium on aluminium oxide and tungsten oxide on silica, to turn a mixture of polyethylene and polypropylene into the monomers propylene and isobutylene with an efficiency of nearly 90 per cent (*Science*, doi.org/nfb7).

Benjamin Ward at Cardiff University, UK, says recycling plastics is made harder by thousands of additives such as dyes, fire retardants and plasticisers, which can make up as much as a third of a finished product and contaminate the end product after recycling. He thinks the new process solves the additive problem, because stripping material down to its constituent gaseous monomers also removes the additives.

Hartwig warns that there are still many hurdles to overcome, and that the process has only been tested in the presence of a small number of common additives. "There will be additives that... will poison, will inhibit the catalyst," he says. This may mean having a way to separate those additives or finding catalysts that are resistant to them, he says.

Cressida Bowyer at the University of Portsmouth, UK, says that even if we have a process that can split waste plastic into constituent parts and withstand additives, other issues remain. The toxicity and disposal of the catalysts and additives must be taken into account, she says. "These could outweigh any perceived benefits of recycling technologies."

"Recycling should not be seen as any kind of solution or rationale to maintaining or increasing production of single-use and unnecessary plastics and continuing the current prevailing take-make-waste culture," she says. ▮

DAVE PATTISON/ALAMY

Polyethylene plastic bags have proved challenging to recycle

Analysis Space flight

Astronaut stranding reveals health of US space programme

The failure of the Starliner capsule has left two astronauts stuck in space, but also proved the overall plan was good, says **Leah Crane**

IT IS official: Butch Wilmore and Sunita Williams are staying on the International Space Station (ISS) until at least February 2025. This is a major setback for Boeing's Starliner, the capsule that brought them there, but it doesn't spell doom for the US space programme. Instead, it highlights the success of the move from governments providing the only rockets to space to the proliferation of commercial space flight options.

This is exactly the contingency that NASA's Commercial Crew Program, which uses spacecraft built by private firms to ferry astronauts to and from the ISS, was planned to handle. "Commercial Crew purposefully chose two providers for redundancy in case of exactly this kind of situation," says Laura Forczyk, an independent consultant in the space industry.

The two NASA astronauts were supposed to return to Earth about a week after they arrived at the ISS aboard Boeing's Starliner capsule on 5 June. But due to problems with the spacecraft, they will now stay for an extended mission before coming home on a SpaceX Crew Dragon craft instead of Starliner.

"If they had only selected one provider, it would have been Boeing, because SpaceX was the risky prospect at the time," says Forczyk. "So in a way, this is a triumph of the Commercial Crew Program."

This mission was Starliner's first crewed test flight, and it was rocky from the start. Leaky valves and thruster failures during the journey into space forced NASA and Boeing to reconsider whether the craft would be safe to shuttle the astronauts home. They ran tests of the thrusters on the ground and the results were inconclusive – there was still some risk of the thrusters failing on the way home.

NASA

Butch Wilmore and Sunita Williams will stay on the ISS until February

The safest backup plan is for the astronauts to stay on the ISS until SpaceX's tried-and-true Crew Dragon capsule has room to bring them home in early 2025. In the meantime, Starliner will autonomously undock from the ISS in September and return to Earth without crew, and Boeing engineers will continue troubleshooting.

"This was a test mission, but sometimes in tests, the answer is, you've got something you need to fix," said retired NASA astronaut Michael Fossum in a statement. "Tests don't always prove that everything worked perfectly."

In a 24 August press conference, NASA administrator Bill Nelson said Starliner will get another shot at flying a crew to the ISS, but others aren't so sure. Boeing's contract states that the craft cannot be certified for real missions until it has had a successful test flight – which this wasn't. If NASA requires Starliner to do another test flight, it could push the first operational flight until 2026 at the earliest, says Forczyk. With the ISS slated to close up shop around 2030, getting Starliner ready for active duty may just not be worth it.

Without the redundancy of the Commercial Crew Program, Starliner's failure could have left the US without a launch provider. As it is, SpaceX will continue shuttling astronauts to and from the ISS. Wilmore and Williams will have to stay on the ISS a bit longer, but they are veteran astronauts and have the experience and equipment to jump right into daily life in space until they can be brought safely back to Earth.

It is even possible the hard work and inconvenience of an extended stay won't outweigh the excitement of life in orbit for Wilmore and Williams. "I know them really well, and in a way, I think they were a little disappointed to fly in space with such a short amount of time," said Fossum. "They both also have done long duration missions on the space station before... and they both loved it." ▮

Health

Fast Lyme disease test could lead to speedier treatment

Tom Leslie

A NEW approach to diagnosing Lyme disease could help people receive treatment sooner, reducing the risk of long-term complications.

Lyme disease is caused by bacteria in the genus *Borrelia* and is transmitted to people through tick bites. Initial symptoms may include fever, headache or loss of energy. If not promptly treated with antibiotics, symptoms can become severe, including ongoing fatigue and aches, heart problems and nerve pain.

Doctors can diagnose the condition if they spot its distinctive bullseye rash, but about 30 per cent of people with Lyme disease don't develop this. If the condition is suspected but there is no rash, a blood sample can be sent for testing to check for antibodies for the disease, indicating an infection.

It can take weeks to get a result, says Dino Di Carlo at the University of California, Los Angeles. Now, he and his colleagues have developed a test that takes just 15 minutes. This contains chains of molecules called peptides that mimic the antigens – the substances that elicit an immune response – on *Borrelia* bacteria.

Any Lyme disease antibodies in a sample of serum – the fluid that is left after blood cells and clotting factors are removed from blood – would bind to these peptides, leading to a positive result.

15

minutes was all that the new test needed to diagnose Lyme disease

The team tested the approach using 30 serum samples, 15 from people confirmed to have the infection and 15 from controls. The test picked up cases 95.5 per cent of the time, with no false positives (*Nature Communications*, doi.org/nd9t). The test hasn't yet been through clinical trials. ▮

New Scientist Live
The human-fungal symbiosis
Hear Nicholas Money on the fungi inside us on 13 October
newscientist.com/nslmag

Food science

Fungus transforms food waste into haute cuisine for Michelin-starred restaurants

Charlotte Lytton

A MOULD that grows on discarded food has been shown to radically alter its taste, allowing food that would otherwise be thrown out to be eaten in a new way.

Neurospora intermedia, an orange fungus cultivated from the byproducts of soya milk production, has been used for centuries to make oncom, a traditional food in Java, Indonesia.

Vayu Hill-Maini at the University of California, Berkeley, and his colleagues have worked with chefs at Michelin-starred restaurants in New York and Copenhagen to develop new foods using the fungus. Some of the results are now appearing on their menus, including a cheesy-tasting toast made from stale bread and a sweet dessert made from sugarless rice custard.

About a third of food globally is wasted, with discarded produce responsible for around 8 per cent of greenhouse gas emissions over its lifetime. Repurposing it into new kinds of food that can be eaten, known as upcycling, can reduce the climate impact of food production by diverting waste from landfill, while also enhancing food security, says Hill-Maini.

"I found it mind-blowing to discover flavours like banana without adding anything besides fungi"

His team has shown that *N. intermedia* can flourish on at least 30 types of agricultural waste, including tomato pomace and banana peel, without producing toxins (*Nature Microbiology*, doi.org/nd92).

The fungus can transform indigestible plant waste into nutritious food in around 36 hours. "It seems to have a unique trajectory on waste, from trash to treasure," says Hill-Maini.

When the team asked Danish consumers to try oncom for the first time, people consistently rated its taste above 6 on a scale of 1 to 9 and described it as "earthy and nutty", he says.

Hill-Maini collaborated with Rasmus Munk, who runs the Alchemist restaurant in Copenhagen, and Andrew Luzmore of Blue Hill at Stone Barns, a restaurant in Tarrytown, New York, to develop foods based on the fungus.

At Alchemist, *N. intermedia* was used in a dessert of jellied plum wine with unsweetened rice custard, which was left to ferment for 60 hours. This process altered both the aroma and taste "in quite a dramatic way", according to Munk.

"I found it mind-blowing to suddenly discover flavours like banana and pickled fruit without adding anything besides the fungi itself," he says. "Of course, all of our wild shots don't work out, but when they do, they can produce quite revolutionary results."

STONE FARM AND ALCHEMIST

Neurospora mould turns sugarless rice custard into a sweet dessert at a restaurant in Copenhagen

The chefs involved hope that by demonstrating what upcycled food can do at the highest level of gastronomy, the concept will gain commercial appeal. "We are just at the beginning stages of unlocking its full potential," says Hill-Maini. ▮

Neuroscience

How your brain knows that the beat is about to change

PEOPLE use two distinct brain networks to anticipate and identify transitions between segments in a piece of music.

Musical boundaries, when one section of a composition ends and another begins, are important to enjoyment of music, particularly in the Western tradition. Otherwise, your favourite hit would sound like a monotonous stream, "similar to reading a text with no punctuation", says Iballa Burunat Perez at the University of Jyväskylä in Finland.

To understand how the brain processes musical boundaries, she and her colleagues analysed brain activity in 36 adults while they listened to three instrumental works from different genres: the Argentinian nuevo tango composition *Adiós Nonino* by Astor Piazzolla, the US progressive metal piece *Stream of Consciousness* by Dream Theater and the Russian ballet classic *The Rite of Spring* by Igor Stravinsky. All of the listeners lived in Finland, and half considered themselves semi-professional or professional musicians.

The researchers found that, just before a musical boundary, a brain network they call the early auditory network activates in anticipation of the musical phrase ending. This network primarily involves auditory areas in the back of the brain's outer region, the cortex.

A different network activates during and after musical transitions. Dubbed the boundary transition network, it is characterised by increased activity in auditory areas towards the middle and front of the cortex (*PNAS*, doi.org/nd6f).

SHUTTERSTOCK/NDAB CREATIVITY

An ability to anticipate shifts in a tune helps us enjoy music

Burunat says the shift in activity between these two areas is similar to how our brains understand the differences between sentences in language.

The musicians and non-musicians engaged the two brain networks differently. For instance, musicians relied on brain areas important for higher-level auditory processing and integration. This may reflect a more specialised understanding of musical boundaries, says Burunat. Non-musicians showed greater connectivity across broader brain regions, indicating a more generalised approach.

The findings may help develop music-based therapies for people with difficulties comprehending language, says Burunat. ▮

Grace Wade

THE WORLD'S GREATEST FESTIVAL OF IDEAS AND DISCOVERIES

12-13 OCTOBER 2024 | SCHOOLS' DAY 14 OCTOBER

EXCEL LONDON AND ONLINE

New Scientist Live

SUPER EARLY BIRD DISCOUNT FOR ONLINE TICKETS ENDS ON SUNDAY

THE SUPER EARLY BIRD DISCOUNT FOR NEW SCIENTIST LIVE ONLINE TICKETS ENDS THIS SUNDAY. IF YOU CAN'T JOIN US AT EXCEL LONDON, TAKE THE OPPORTUNITY TO JOIN US ONLINE FROM ANYWHERE IN THE WORLD FOR A WEEKEND OF INSPIRING TALKS AND GROUNDBREAKING DISCOVERIES.

YOUR ONLINE TICKET INCLUDES:

ACCESS TO 40+ FASCINATING TALKS
by world-class scientists and researchers

LIVE Q&A SESSIONS WITH EXPERTS
and interactive discussions with fellow viewers

ON-DEMAND ACCESS FOR A YEAR
to watch or rewatch your favourite talks anytime

FIND OUT MORE AT

NEWSCIENTIST.COM/NSL2024

FEATURE PARTNERS: FARMERS WEEKLY, KINGS COLLEGE LONDON

EVENT PARTNER: STEM LEARNING

SCHOOLS' DAY PARTNER: Technicians We make the difference

CHARITY PARTNER: Medical Research Foundation

WIDENING PARTICIPATION PARTNER: THE FUSION CLUSTER

MEDIA PARTNER: i

Views

The columnist
Annalee Newitz on social media disinformation p22

Aperture
Zooming in on the beautiful world of seeds p24

Letters
The case for and against an Alan Turing chatbot p26

Culture
The author of *Sapiens* attempts to tackle info networks p28

Culture
A podcast explores testosterone tests in elite running p30

Comment

Changing the script

Media portrayals of addiction, such as celebrity biopics, peddle a dangerous fiction about substance use disorder, says **Anna Wolfe**

A PODCAST and a comment on a London Tube line one morning made me acutely aware of the disconnect in how we discuss addiction.

The podcast was an episode of *Empathy for the Devil* featuring mental health and addiction specialists compassionately exploring the struggles and death of Rolling Stones member Brian Jones through the lens of his childhood, environment and trauma. The comment was a muttered word, "junkie", directed at a man asking for money in our carriage. That word overshadowed the more profound questions in the podcast: What led this man to his situation? How was a complex tangle of societal issues reduced to a tale of personal failure?

I wondered if the passenger would have said the same to me because, technically speaking, I'm a "junkie" too – I'm just one of the lucky ones that got sober.

With September dedicated to National Recovery Month, we need to reconsider how every headline, film and celebrity scandal shapes our understanding of addiction, especially when claiming to tell "true stories".

Take biopics. These films, marketed as reflections of reality, wield enormous influence over public perceptions of addiction. This is borne out by a 2023 study showing the content we consume shapes how we view and treat the condition. It highlights the effect of media in solidifying societal attitudes, and suggests repeated exposure to these portrayals can make it increasingly difficult to shift entrenched opinions.

ADRIÀ VOLTÀ

Back to Black, for example, reduces Amy Winehouse to the "troubled artist" stereotype, ignoring the complexities of her addiction and mental health. *Bohemian Rhapsody* depicts Freddie Mercury's addiction as a personal failing.

The issue isn't just what's shown on screen, but what's left out. By neglecting to address root causes, films often reduce addiction to a series of poor choices, lack of values and weakness. This kind of framing not only reinforces damaging stereotypes but also contributes to a cultural landscape that dehumanises those who have problems with drug use. Worse yet, it influences policies that focus on punishment rather than rehabilitation, ignoring the more complex realities of addiction.

These films are just one part of an overwhelming messaging machine of misinformation. Tabloids turn struggles to clickbait; government campaigns, such as the UK's "Know Your Limits" initiative, which included scenes of a girl vomiting, stoke shame; schools dish out outdated and simplistic education materials. It's a relentless flood of warped ideas, leaving the public adrift in a sea of misconceptions.

This misalignment has real-world consequences. The US opioid crisis shows how media coverage impacts policy, with one study finding that racial bias disproportionately hindered harm reduction strategies in Black and Hispanic communities. In the UK, high addiction rates in socioeconomically deprived areas and focus on prison over prevention raise concerns about misallocated funding, leaving mental health and ongoing support deprioritised.

The World Health Organization and England's Office for Health Improvement and Disparities have advocated for a holistic approach to addiction treatment, one that addresses underlying issues like poverty, social isolation, mental health and trauma, rather than merely treating symptoms. The aim is to break the cycle and support long-term recovery.

Of course film-makers aren't responsible for public health, but choosing to tell the whole story of addiction could alter perceptions. While the stories of celebrities and the person on the tube may seem worlds apart, they are threads in the same tapestry. And prioritising truth over drama can save lives.

Anna Wolfe is a freelance journalist based in London

This changes everything

Getting to the truth

As misinformation about the upcoming US elections rockets across social media, we need transparency from the companies disseminating it, says **Annalee Newitz**

Annalee Newitz is a science journalist and author. Their latest book is *Stories Are Weapons: Psychological warfare and the American mind.* They are the co-host of the Hugo-winning podcast *Our Opinions Are Correct*. You can follow them @annaleen and their website is techsploitation.com

Annalee's week

What I'm listening to

The podcast Tested*, by Rose Eveleth, about the history and science of sex testing at the Olympics* *(see review, page 30)*

What I'm reading

Peter Pomerantsev's How to Win an Information War*, a tale of British psychological operations in the second world war*

What I'm working on

Learning about the history of biang biang noodles

This column appears monthly. Up next week: Rowan Hooper

HERE in the US, we are deep into election season, and it is impossible to debate politics without also debating how technology is distorting it. There are the AI-generated deepfake images Donald Trump circulated of Taylor Swift appearing to endorse his campaign, as well as disproven conspiracy theories about rigged voting machines. And then there are the malicious disinformation campaigns on social media, which are coming from everywhere – with seemingly no solutions in sight.

The Microsoft Threat Analysis Center released a report charting a recent rise in fake activist and news websites, as well as fake accounts on social media, created by operatives in Russia, Iran and China. Generally, their goals are to create chaos during the election and exacerbate tensions over race, gender and other hot-button cultural issues.

On X, Elon Musk released a chatbot called Grok, which was spouting misinformation for several weeks about when to vote. Meanwhile, Meta, owner of Facebook, announced it has a solution to the political misinformation conundrum: its social platform Threads won't "recommend" political content. This is akin to claiming one can remove butter from shortbread – it sounds like a healthy goal until you try to separate out what is "political" from everything else.

I recently talked about all this at the National Book Festival in Washington DC on a panel with propaganda expert Peter Pomerantsev. Our moderator asked us if the 2024 election is better or worse than the 2020 one in terms of misinformation and disinformation, with the latter being false information intended to deceive or mislead. It is a complicated question, because social media has changed so much since 2020.

I think people are more aware of online misinformation, but they are more confused by it than ever. Partly that is because the previous generation of social platforms is crumbling away, and the new ones have fragmented us into dozens of spaces. But in the US, this confusion is also engineered. Politicians have sued and hamstrung academic groups like the Stanford Internet Observatory in California, which tracked US election misinformation online in 2020. We know the propaganda is out there, but nobody is able to analyse it adequately.

"It isn't as if online disinformation will evaporate after the US elections. Indeed, many people crave it"

Plus, as Pomerantsev said, it isn't as if online disinformation will evaporate after the elections. Indeed, many people crave it. Propaganda makes us feel like we are part of a community, united against a common enemy. This insight is particularly profound when it comes to social media, which is also designed to make people feel like they are part of a community even when they are alone with their glowing screen.

We are at a weird historical juncture. Experts may understand why propaganda works, but no longer know how it reaches us on a technical level. When the military sent propaganda to adversaries in the past century, they loaded pamphlets into planes and dropped them behind enemy lines. It was pretty obvious where the information was coming from, and why. Today, companies hide the way false information rockets across their platforms. Their algorithms for surfacing content are secret, and so are the identities of many people posting. We don't need better technology to solve our misinformation problems; we need transparency from the companies disseminating it. They should be honest about where the content in our feeds is coming from, because most of what we see is determined by algorithm, and comes from strangers we never opted to follow. If researchers knew how information got into our feeds, and how people respond to it, they might come up with tools that prevent dangerous lies from spreading.

Still, there are non-technical solutions too. Bestselling author Rebecca Yarros, whose fantasy novel *Fourth Wing* is about a group of students at a war college for dragon riders, also spoke at the National Book Festival . As Yarros's main character Violet gains more experience, she realises that the leaders of the college have been rewriting history books to justify a centuries-long war. In reality, her people started the war by colonising the group Violet once thought were the baddies.

Yarros explained that she wrote the book in part to protest US politicians who are removing references to slavery from history books. Many audience members thanked her for telling a story that debunked propaganda and was on the side of colonised people.

I walked around with a smile for a while afterwards. Partly it was the fizz of being in a real-life community, not one fabricated by propaganda. But it was more than that. Popular stories like *Fourth Wing* give me hope that the escape from propaganda can be just as compelling as the escape into it. ▮

Discovery Tours

NewScientist

New perspectives on cruising the polar regions

Arctic expedition cruise with Richard Dawkins, Svalbard, Norway

22 June 2025 | 12 days

We are excited to launch a brand-new expedition experience with evolutionary biologist and highly regarded author Richard Dawkins! Explore the northernmost region of Earth, the realm of the polar bear and the midnight sun, while travelling aboard the Greg Mortimer, which is at the cutting edge of nautical technology. This cruise will be a truly enriching trip of a lifetime.

- **Venture close to 80° north, searching for polar bears on pack ice.**
- **Fascinating talks from evolutionary biologist and author Richard Dawkins plus *New Scientist* contributors and expedition crew.**
- **Discover the thrill of seeing species such as walrus, seals, whales, reindeer, arctic fox, guillemots and puffins.**
- **Cruise along blue glacier fronts and through stunning fjords on a purpose-built intimate polar expedition ship.**
- **Enjoy tundra hikes amid stunningly beautiful scenery.**
- **Daily Zodiac boat safaris exploring fjords and glaciers.**

Total solar eclipse 2026: Iceland to Greenland polar cruise

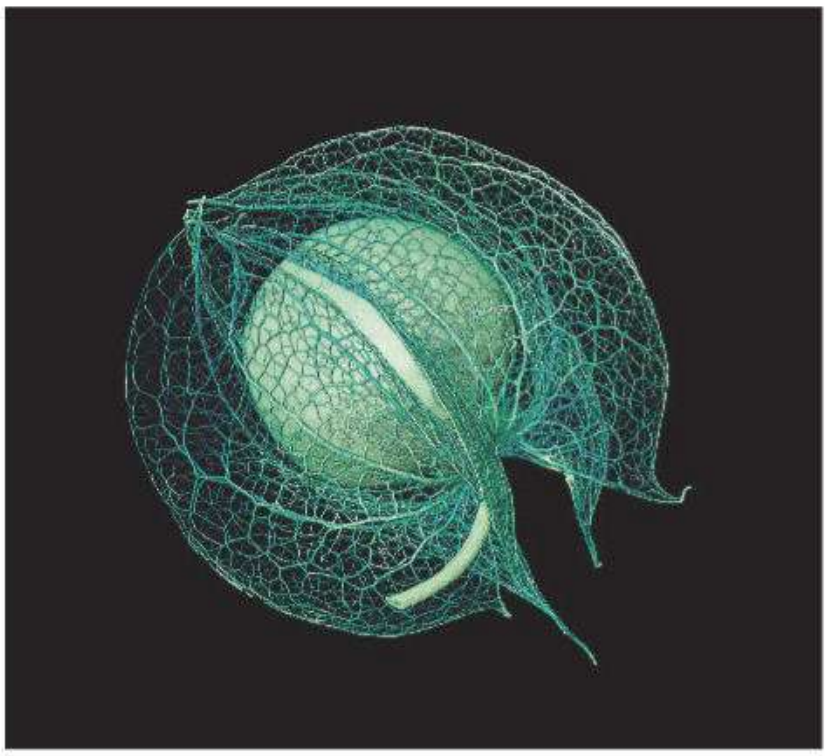
7 August 2026 | 13 days

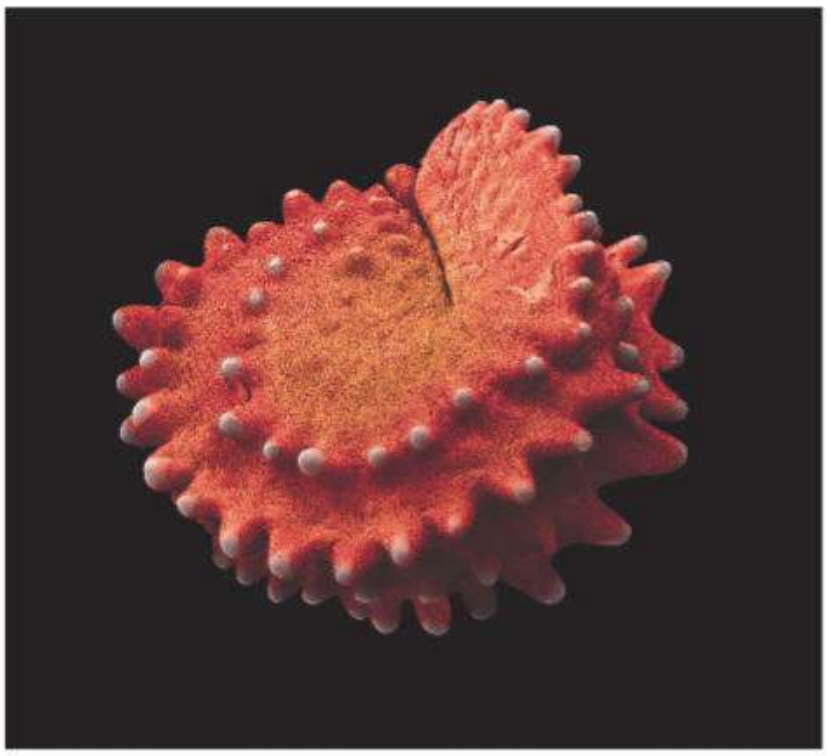
Experience a total solar eclipse while surrounded by a stunning Arctic landscape, where the ethereal silence is broken only by the distant calls of the wildlife. Sail aboard a new boutique, state-of-the-art polar expedition vessel, the Sylvia Earle, one of a handful of passenger ships to feature the revolutionary Ulstein X-BOW, reducing fuel consumption and allowing a sleeker cruising experience.

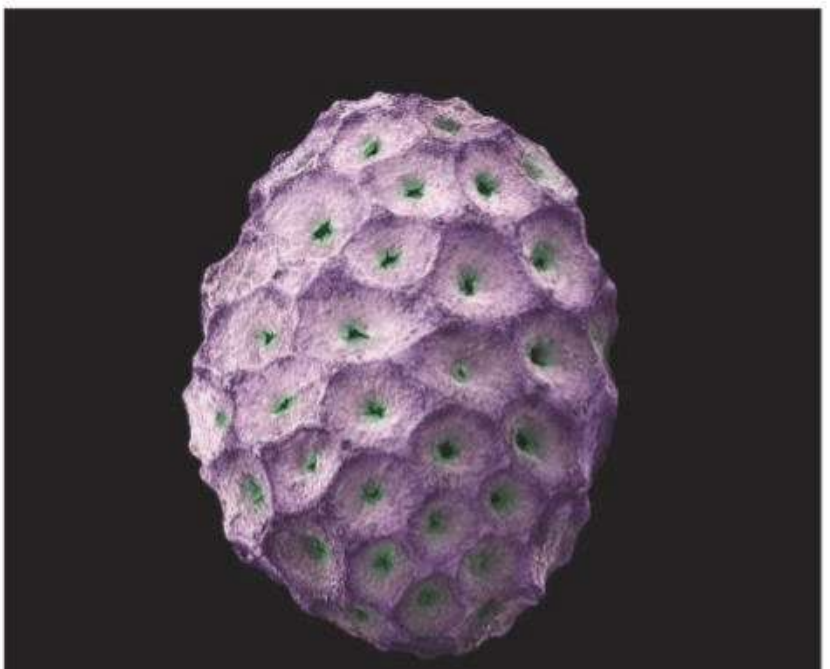
- **Explore the majestic Scoresby Sund in Greenland, the world's longest fjord system.**
- **Accompanied throughout and with talks by astronomer and eclipse expert Jamie Carter.**
- **Encounter a fascinating variety of species, including barnacle geese, musk oxen, Arctic foxes, Atlantic puffins and walruses.**
- **Led by a highly knowledgeable and supportive expedition team, who will give a full programme of talks, shore visits and Zodiac boat safaris.**
- **Enjoy short tundra hikes amid the beautiful scenery of the fjord system.**
- **Explore Iceland's Golden Triangle, including Þingvellir National Park and the Geyser geothermal area.**

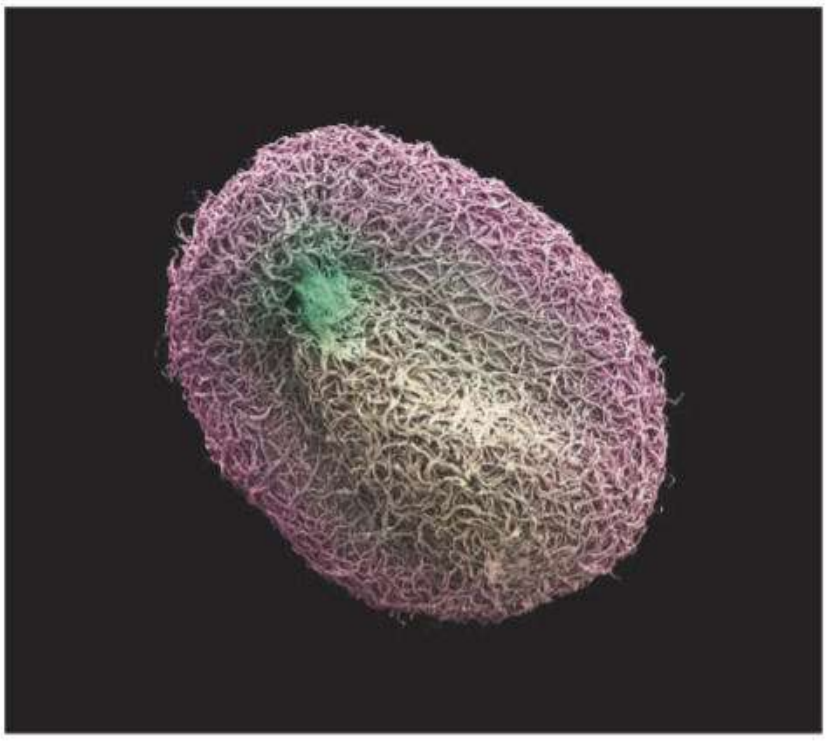
Find out more

newscientist.com/tours









Small wonder

Rob Kesseler & Wolfgang Stuppy
Papadakis

SINCE the emergence of seeds around 360 million years ago, plants have flourished – from the most imposing of giant sequoias to the daintiest of herbs. The new book *Seeds: Time capsules of life* by visual artist Rob Kesseler and botanist Wolfgang Stuppy explores these tiny natural wonders using a mixture of scanning electron microscopy and close-up photographs.

In the top, far-left image, a delicate, leafy structure known as a calyx surrounds the fruit of the apple-of-Peru (*Nicandra physalodes*). Below it is a 3.4-millimetre-wide cross-section of a blue passion flower (*Passiflora caerulea*) ovary, stuffed with mature ovules that develop into seeds once it is fertilised. And the sinewy, textured nutlet of a yellow-flowered skullcap (*Scutellaria orientalis*) is seen at bottom, far left. Nutlets are very small versions of nuts, which are fruits with a hard outer shell and dry seeds inside.

The *Mesembryanthemum tetragonum*, a small shrub native to southern Africa, boasts a spectacular, bright red seed that is just 1.3 mm in diameter (top middle). Below it, at a mere 0.8-mm long, is the seed of a Douglas' phacelia (*Phacelia douglasii*). The honeycomb-shaped seed of *Caiophora arechavaletae*, bottom middle, is lightweight enough to be dispersed by the wind. Taking centre stage is the vivid ovarian cross-section of a Lady Margaret passionflower, stretching 4 mm.

The life forms of Earth are amazing, says Stuppy. "Over millions of years, they have come up with these absolutely amazing adaptations, which helps them interact with animals and the environment." ▮

Chen Ly

Editor's pick

The case for and against an Alan Turing AI chatbot

17 August, p 21

From Paul Whiteley, Bittaford, Devon, UK

I read with horror about plans to create an AI model of Alan Turing, effectively putting words into the mouth of someone long dead.

We will never know what goes on inside the mind of a genius – that is what sets them apart from us ordinary mortals. I presume, though, that much of Turing's later life was spent thinking about what makes people different from "thinking machines".

The suggestion that someone could produce and bottle the essence of another with so much confidence that they could "put words into their mouth" is a tasteless one.

From Graham Barker, London, UK

Matthew Sparkes is too cautious in opposing an AI recreation of Alan Turing. A tour of Bletchley Park where he worked pays homage to those clever and dedicated code breakers who reduced the length of the second world war by two years, but it can be a little dry. A chatbot conversation with an interactive AI model of Turing would certainly liven it up.

OK to be cynical if you take a broader view

17 August, p 36

From Tim Stevenson, Great Missenden, Buckinghamshire, UK

Jamil Zaki defines cynicism as the "theory that, in general, humanity is selfish, greedy and dishonest" and deems holding it to be psychologically damaging.

However, it is fine to endorse the cynical belief that we belong to a deeply dysfunctional species if you include two caveats. These are that the majority of people are decent, honest and kind; and that life is complicated and all generalisations are false.

Avert farm emissions via genetic modification

17 August, p 13

From Geoff Harding, Sydney, Australia

It is obvious that the eating of meat, particularly beef, must be reduced, but the problem of a rising world population and increasing average wealth and consumption demands every possible means of reducing greenhouse gas emissions from farming. Although there has always been some resistance to consumption of genetically modified crops, the potential advantages, such as increased yield, growth rate and disease resistance, leave little choice but to adopt these foods as staples.

Deep-sea mining could be the best way forward

Letters, 17 August

From Eric Kvaalen, Les Essarts-le-Roi, France

It is unfortunate that the study that found "dark oxygen" produced by metallic nodules on the seabed is having such a quick and negative effect on potential deep-sea mining. This form of mining may be the least damaging way to get the metals we need for the transition to a low-carbon economy. The ecological effect of "dark oxygen", if it really exists, is probably negligible, and further research will clear things up.

On the plan to bring the ISS crashing back to Earth

10 August, p 36

From Mark Kaminsky, Sunnyvale, California, US

It seems to me that NASA may be giving too little consideration to the nightmare scenario that de-orbiting the International Space Station could injure people on Earth. I would like to suggest that simply separating the 16 pressurised modules that make up the station and de-orbiting each separately would greatly reduce the overall risk.

It also seems to be a good idea to inventory the contents of each module and determine whether some of these items would be best returned to Earth in cargo capsules, as the lower the mass of each de-orbited piece, the safer it would be, but that is a minor issue.

From Andrew Hawkins, Peaslake, Surrey, UK

For a glorious finale for the ISS, adapt it for a Mars return mission. We could ensure there is adequate accommodation for five to six crew members, attach a thruster rocket and fuel, put general supplies in pods and add a lander for crew to visit the surface once in Mars orbit. They could then collect mineral samples and return to Earth to a triumphant welcome.

From Andrew Underwood, Nelson, New Zealand

It seems highly problematic to allow the ISS to partially burn up in our atmosphere and then crash on Earth, once it is no longer deemed viable for science. The danger, pollution and disruption created, not to mention the waste, would be absurd considering there may be a better option: why not strap on engines to boost it out to the moon and let it crash there?

As the station wouldn't burn up on the moon, it might have considerable value, even if badly damaged from the crash, as a localised scrapyard for materials that may be useful in the construction of a moon base one day. A lot of refined metals, wires, electronics and so forth would be then on hand, rather than needing to be mined from the moon or expensively launched from Earth. Isn't anyone in the various space agencies conscious of waste?

There are better ways to store energy in homes

Letters, 10 August

From Brian Pollard, Launceston, Cornwall, UK

Bryn Glover mentions the idea of weights being lifted in order to store energy, suggesting putting a falling-weight system in every house, lifted by energy from solar panels and allowed to fall during the night to provide heat and light. Such an arrangement could indeed provide light, but definitely not heat. It turns out that the energy stored in weights is remarkably small.

A 1-tonne domestic weight raised, say, 10 metres would store 27 watt-hours of energy, sufficient to power a 5-watt LED for just over 5 hours. This is an impractical way of storing energy. For any energy storage idea, it is essential to assess it in this way before deciding whether the whole thing is going to be practical.

Why bother, if we are all living in a simulation?

Letters, 10 August

From Sylvia Potter, Godalming, Surrey, UK

Global heating is causing me a certain amount of inconvenience. I avoid flying, use public transport, recycle plastic and so on. However, if I am living in a simulation, a suggestion that several readers have raised recently, why should I bother? Whoever or whatever created the simulation can always program a better world next time.

Want to get in touch?

Send letters to letters@newscientist.com; see terms at newscientist.com/letters

Letters sent to New Scientist, 9 Derry Street, London, W8 5HY will be delayed

For the record

The gamma-ray burst GRB221009A is the brightest explosion astronomers have observed (3 August, p 13).

Only the finest farmers make it into our beauty parade

Shortly after harvest each year the best hop farmers in the UK journey to our brewery in Yorkshire. They bring with them carefully packed parcels of their finest crops. In what has become known as the *hop beauty parade* our expert brewers meticulously assess each batch, judging not just looks but also personality. The brewers rub each hop in their warm hands to feel the quality of the resins and release the delicate aromas that are vital to the signature flavour and balance of our beer. Only then are the *choicest* whole leaf hops selected to brew your *beautiful* pint of Landlord.

All for that taste of Taylor's

TIMOTHY TAYLOR'S
1858
CHAMPIONSHIP BEERS
LANDLORD
THE CLASSIC PALE ALE ABV 4.3%

Podcast
NewScientist

The New Scientist Weekly podcast

Our prizewinning show brings you a curated selection of the essential stories of the week.

Hosts Timothy Revell and Christie Taylor are joined by *New Scientist* reporters and outside experts as they discuss the latest news and breakthroughs – and what they mean for you.

Feed your curiosity for free every week with New Scientist Weekly.

Listen at newscientist.com/podcasts

Follow us on X @newscientistpod

Listen on Apple Podcasts
Listen on Spotify
Listen on Google Podcasts
Listen on Stitcher
YouTube

Information overload

The author of *Sapiens* has turned his attention to the information networks that shape our societies, and he is out of his depth, says **Michael Marshall**

Book
Nexus
Yuval Noah Harari
Fern Press, out 10 September

READING *Nexus* is a strange experience. The quality of the text lurches up and down: one minute you are reading something incisive, the next you are wading through banalities.

Its author, Yuval Noah Harari, is a medieval historian most famous for his book *Sapiens*, a whistlestop history of humanity from the Stone Age to the present day. Its central thesis is that humans came to dominate the planet because we can believe in things that only exist in our shared imaginations, such as "gods, states, money and human rights". This isn't original: Terry Pratchett's *Hogfather* said the same thing with more wit and less verbiage in 1996. And Harari gave little evidence that a shared imagination was the primary marker of human uniqueness, he just asserted it.

The book was a surprise bestseller and Harari became a public intellectual. Now comes *Nexus*, about the ways information is transmitted through societies. In it, Harari sets out to show how the information network changed as we adopted farming, cities and the internet.

"It is easy to see why so many have fallen under his spell, but when you think about what he is saying, it is obvious"

He lucidly sets out how holy books like the Bible were curated by institutions that chose what to include or leave out, and how the process of science enables error-correction. It is easy to see why so many have fallen under his spell.

When it comes to his main argument, he engagingly describes how information generated by institutions, like courts and universities, circulates through a web of connections in democratic societies. Dictatorships, in contrast, draw all information inwards towards the dictator, so are less likely to self-correct. But when you stop to think about this, it is obvious. I don't doubt that he is right about information flowing differently in democratic and authoritarian societies – although he doesn't quantify it – but didn't we know that? Existing ideas like "liberalism" and "checks and balances" captured it nicely.

There are many silly bits. Harari claims people don't trust bureaucracies because they don't understand them. Bizarrely, he blames storytellers, who he says don't tell stories about how bureaucracies process information, favouring those about family rivalries. *Hamlet* and *Succession* may be more about dysfunctional families than the institutions they control, but what about the myriad of stories about police, lawyers and the military?

The second half of the book is about computers and artificial intelligence, which could disrupt our information networks – including democracy. Most of the things Harari is worried about seem reasonable, like generative AIs poisoning online discussions, but he adds nothing new.

When Harari does strike out on his own, he stumbles. In chapter 1, he sets out a "complex and crucial argument" that is "the theoretical basis of the book". The thesis is that "most information is not an attempt to represent reality" – well, yes, fiction exists. Instead, "what information does is to create new realities by tying together disparate things – whether couples or empires".

In other words, information is used to make connections between concepts. This is inadequate. Winston Churchill is connected to Harry Truman and Adolf Hitler, for example, but not in the same way.

Harari then confuses things further by saying that information creates connections between people, as when a crowd dances to music. This is a different kind of connection, but Harari conflates the two. Why? Well, Harari's big idea in *Sapiens* was that humanity can connect large numbers of people through information. Now he has defined information as something that connects people. It is perfect circular reasoning.

It isn't that there is nothing good in *Nexus*, but readers shouldn't have to pick through a sludge of sloppy thinking for rare nuggets of insight. If Harari is, as his author biography claims, "one of the world's most influential public intellectuals", our information network is broken.

Michael Marshall is a writer based in Devon, UK

The invention of the printing press helped the distribution of information

JUSTIN SULLIVAN/GETTY IMAGES

Close encounters

Two new books offer contrasting perspectives on how UFOs captured the world's imagination, finds **Chen Ly**

Book

After the Flying Saucers Came
Greg Eghigian

Oxford University Press (out now in the US; 30 September in the UK)

Imminent
Luis Elizondo
John Blake (UK); William Morrow (US)

DAVID MCNEW/NEWSMAKERS/GETTY IMAGES

News reports and media helped fuel popular fascination with flying saucers

ON 24 June 1947, pilot Kenneth Arnold set off on what seemed like an ordinary flight from Chehalis to Yakima, both in Washington. The skies were clear and the winds mild – perfect flying conditions. But midway through his journey, Arnold noticed something unusual: a bright flash, like sunlight reflecting off a mirror. Worried about a potential collision, he scanned the skies, only to spot a distant plane trailing him by about 24 kilometres. Then a series of dazzling lights caught his eye – flat, circular objects racing across the sky at astonishing speeds.

Arnold described how the objects "flew like a saucer would if you skipped it across water". His words ignited decades of fascination with "flying saucers" or, as we now call them, unidentified flying objects (UFOs) or unidentified anomalous phenomena (UAP).

This incident is the starting point for Greg Eghigian's *After the Flying Saucers Came: A global history of the UFO phenomenon*, which explores how UFOs took hold of the public consciousness. Eghigian, a professor of history and bioethics at Pennsylvania State University, argues that Arnold's sighting emerged at a pivotal moment in history – just after the second world war and during the onset of the cold war, a time marked by technological advancements and rising tensions between global powers. The world was on edge, primed to embrace stories of mysterious phenomena amid the era's uncertainty.

By the 1950s, reports of strange aerial phenomena were pouring in. At the time, the leading theory was that these sightings were evidence of superpowers secretly developing advanced weapons. One particularly bizarre conspiracy, as Eghigian describes, suggested that Adolf Hitler and his scientists had escaped Europe with flying saucer technology and were hiding in Antarctica or the Arctic, preparing to strike the Allies.

As UFO sightings became more frequent, another explanation surfaced: these objects were of extraterrestrial origin. The media fuelled public imagination, reinforcing the belief aliens might have already visited Earth.

Eghigian's approach is refreshingly balanced. He neither dismisses UFOs as figments of imagination nor endorses them as evidence of alien visitations. Instead, he offers a nuanced historical account filled with colourful characters who have shaped the UFO debate, leaving readers to decide what they believe.

His narrative also touches on government officials tasked with investigating these phenomena, including Luis Elizondo, a former military intelligence officer involved in the US's secretive Advanced Aerospace Threat Identification Program (AATIP). Elizondo's own book *Imminent: Inside the Pentagon's hunt for UFOs* offers a personal perspective on UFOs. It provides a candid look into his life and work, where he boldly asserts that alien life exists and has already visited Earth – though he acknowledges no unclassified evidence proves this.

Whether or not you are convinced by the extraterrestrial origins of UFOs, these books make it clear the phenomenon is about more than the "truth" of alien life. It touches on broader issues, from government transparency to public trust and the limits of scientific inquiry. While scepticism is warranted, both books compellingly demonstrate that the idea of UFOs goes far beyond simple curiosity – it is a reflection of our hopes, fears and the complexities of the modern world.

Chen Ly is a writer based in London

New Scientist *recommends*

Liz Else
Senior culture editor
London

I have been lucky enough to watch a project evolve: **Sonic Spider** is the world's first eight-legged musical instrument, 4 metres in diameter with piano wires strung on spindly, steel legs. I saw its first performance last year and was hooked.

Musicians pluck, strike and bow the taut wires to take you into the alien world of a female orb web spider waiting for what the night will bring. Blind, she knows her world only through vibrations arriving along the silken strands of her web.

The vibrations the performers create make music as I have never

heard it before, with sustained harmonics alongside staccato taps and clunks. Other instruments represent what excites the spider: trapped flies, predators and amorous males that may become lovers, lunch or both. It is a real trip inside another mind.

Catch Sonic Spider at The Dome, University of East London, Stratford, on 15 September during the British Science Festival. You may even get to play the spider.

C. BERESFORD

Sport's cruellest test

Would you change your body to do what you love? A deeply researched podcast follows two runners facing a tough choice, finds **Christie Taylor**

Podcast
Tested
Rose Eveleth
NPR and CBC

THE Olympics are over. But I am still thinking about the displays of strength, skill, teamwork – and joy. Decathlete Markus Rooth skipping as he realised he had won his 100 metre heat. The women of Italy's gold medal-winning fencing team huddled to celebrate each other. Gymnast Jordan Chiles almost crying at the conclusion of her dazzling floor routine while her proud father thumped his chest in the stands.

I am also thinking about athletes who weren't in Paris, such as Namibian sprinter Christine Mboma, who won silver in the 200 metres at the Tokyo Olympics at 18. She loves to run – it is where she can forget the hardest parts of her life: "I don't love it to become famous... It's in my blood." Then there is Kenya's Maximila Imali, a standout in the 400 and 800 metres for the past decade and, more recently, in the 100 and 200. She has held national records in the 100, 200 and 400, as well as the 4 x 200 metres relay.

The pair are at the centre of *Tested*, a six-part podcast hosted by science journalist Rose Eveleth. It is about how sports have drawn the line between men and women – usually at women's expense. Eveleth spent nearly a decade researching the stories that became *Tested* and it shows: each episode is carefully researched and backed by many references.

Like others before them, both Imali's and Mboma's early successes made their womanhood suspect to some. Given blood tests and invasive physical exams ("I went home crying," says Imali) at the behest of World Athletics, the body governing international track and field, they were faced with a career-defining choice.

Both see themselves as women, and always have. But World Athletics classes them as having differences in sex development, also known as intersex. This is any of several conditions characterised by someone's sex chromosomes, balance of sex hormones, internal anatomy or external genitalia diverging from the expected.

"*Tested* is about how sports have drawn the line between men and women – usually at women's expense"

Mboma and Imali have higher levels of testosterone than average for women without differences in sex development. They received an ultimatum: to run at elite level, they must lower this hormone to what World Athletics deems an acceptable level – a target above the average for most women, but below the lowest level typically seen in men.

Tested follows their responses. Mboma chooses to suppress her testosterone, a difficult trial-and-error process for which she and her doctor receive little help, and one the World Medical Association considers unethical. She tries, and fails, to qualify for the Paris games.

As for Imali, at 28, every missed Olympics may be her last chance. Yet she decides not to lower her testosterone, but to fight via the international sports court for her right to compete. That verdict is unresolved at the podcast's end.

These are just two stories in the century-plus history of women in elite athletics, which moves from a brief, humiliating era of "nude parades" and genital inspections to decades of blood tests and "certificates of femininity". Today, the test for running is based on testosterone levels. But, as *Tested* shows, there is so much we still don't know about this hormone.

Among the other questions the podcast asks are why is everyone who has been dubbed "too masculine" since 2009 a women of colour from a lower-income nation? How much does testosterone actually matter in performance? Why are sex hormones the basis of division at all when so many other factors drive success in sports – including other genetics and your country's prosperity? What is the point of these categories we have made in the name of fairness?

Science alone can't answer. Nor will this series. But what *Tested* does so well is context: history, science, contested data, politics and an invitation to think more deeply about things we take for granted. And we are also invited to wonder, with Eveleth: "How much suffering is worth allowing – and whose – in the name of categorising?" ▮

Runners Christine Mboma (below) and Maximila Imali (bottom)

MARK SCHIEFELBEIN/AP/ALAMY

XINHUA NEWS AGENCY/EYEVINE

DPA PICTURE ALLIANCE/ALAMY

The athletics stadium at the Paris Olympics last month

GALAXY ON GLASS

SPECTACULAR WALL ART FROM ASTROPHOTOGRAPHER CHRIS BAKER

READER DISCOUNT
All images have a 15% discount this month! Simply use the code NS24 at check-out

www.galaxyonglass.com
chris@galaxyonglass.com | +44 (0)7814 181647

New Scientist Jobs

Recruit the brightest minds in science

At New Scientist Jobs, we can help you to reach, engage and attract the highest-quality job applicants, wherever they are. Over 70,000 people* come to our site every month looking for their dream job and ideal employer – which could be you!

Visit newscientistjobs.com

*Source: Google Analysis Jan-Dec 2023

Reality's comeback

Quantum theory seems to have killed off any vestiges of what we might recognise as reality. Now there's an audacious plan to win it back, reports **Karmela Padavic-Callaghan**

AS ONE of the original architects of quantum theory, perhaps our most successful scientific idea, you would think that Niels Bohr would have been interested in the nature of reality. The subjects of his studies were atoms, electrons, photons – the things we think of as the fundamental ingredients of the universe.

But for Bohr, reality was actually none of his business. "It is wrong to think that the task of physics is to find out how nature is," he said in an often-repeated quote from the early days of quantum theory. "Physics concerns what we can say about nature."

Though this distinction may sound pedantic, it can't be dismissed when it comes to quantum physics. The picture this theory paints of the subatomic world is perplexing: particles can seemingly exist in two places at once, time stands still and there is no such thing as empty space. Can that really be what reality is like?

Some physicists shrug off the question. Like Bohr, they aren't talking about reality at all, only our pale perception of it. But many find this viewpoint deeply unsatisfying and want to believe in a world composed of sensible objects that exist independently of what we know about them. They are, in other words, realists. One of them is Robert Spekkens at the Perimeter Institute in Canada, who has a plan to free reality from the century-long quantum mess it has been in. He argues that reality is real after all – as long as we are prepared to modify what "real" means.

Since its birth roughly a century ago, thanks to Bohr and others, quantum mechanics has been incredibly successful. Understanding its rules and the particles that must follow them led us to develop technologies ranging from semiconductor chips, which make our computers and phones work, to quantum computers, which promise to be their more powerful successors. But from the start, it was mind-bendingly difficult to accept some of its implications.

Suppose you have two closed, opaque boxes, one holding a marble and one containing a quantum particle, like an electron. If you open the box with the marble and measure its position, you can rest assured that not much was different before you took a peek. In contrast, because the electron must follow quantum rules, there is no simple way to connect its out-of-sight past to the moment of measurement. Physicists instead must describe the particle's past using the wave function, a mathematical formula that only offers the probability of finding the electron in one place or another. Before you lift the lid, the best you can do is imagine the electron as a cloud of possibilities.

Losing touch with reality

The challenge of interpreting what this really means is known as the measurement problem – and it is a gauntlet thrown down at the feet of realism. If an electron is real, why doesn't it behave like a marble? "People should be thinking about this if they're interested in the nature of reality," says philosopher of science James Ladyman at the University of Bristol, UK.

Reality's credentials look even more dubious if you consider a pair of particles. These can be quantum entangled, which means their characteristics correlate even when separated by distances so vast that no signal could conceivably travel between them. This flies in the face of a principle called locality, which says that for things to influence each other, they must be physically close. The fact that entanglement was "non-local" greatly bothered Albert Einstein, who called it "spooky action at a distance".

So what are we to make of this decidedly unreal picture of reality? You could side with Bohr and say there's no real problem. Forget reality itself, all we can know is what we know about reality. Many of Bohr's contemporaries, including Einstein, were incensed by this idea, as were generations of scientists that followed. Like Spekkens, they were and are realists. For them, if quantum phenomena seem weird, then we must be missing a piece of the puzzle.

"Realism is, loosely speaking, the belief that the world exists independent of us and that there is a truth about how things 'really' are," says Sabine Hossenfelder at the Ludwig Maximilian University of Munich in Germany. "It is a philosophical position, not a scientific one, though I suspect that most scientists are realists."

As realism is more of a philosophical stance than anything else, physicists often instead discuss the more concrete and experimentally testable notion of "local realism" – a combination of localism and realism, where Einstein's "spookiness" is explicitly forbidden.

There have been abundant efforts to create a tweaked version of quantum mechanics that adheres to local realism. Yet none has been successful enough to truly tip the scale. "The fact we have not yet achieved broad consensus on how to interpret the formulas of quantum theory means that none of the proposals on the table have got it right," says Spekkens.

This isn't purely a philosophical debate for Spekkens, it is practical too. One of the headline goals in modern physics is to combine quantum theory with Einstein's general relativity, and so find a unified theory that explains all the fundamental forces of nature in one go. But ›

RYAN WILLS; ADBOESTOCK/GETTY IMAGES

despite decades of effort, there's a sense that progress has stalled. Spekkens blames this on our lack of understanding of quantum theory as it stands. "The way you think about the formulas of quantum mechanics will impact very significantly how you approach that project," he says. "Not having the right interpretation is going to impede you."

He isn't the first to try to rescue realism. Starting decades ago, scientists have been pursuing the same ends through so-called hidden-variable theories. Here, physicists assert that there must be some hidden variable – a factor that, by definition, we can't know or measure – that would explain the transition a particle makes when we observe it snap from nebulous wavefunction to definite position. In the 1960s, however, physicist John Stewart Bell came up with a mathematical test of a whole swathe of local hidden-variable theories – a subset that also requires that the world be local – and its results weren't promising.

Bell considered taking two entangled particles, making a series of measurements on each separately, then analysing the distribution of those measurements. He wanted to determine how that distribution would differ in a world that followed a local hidden-variable theory – a realist world where no odd, far-reaching correlations happen – and a world governed by quantum theory where entanglement is as counterintuitive as it seems. His test, now known as Bell's inequality, does exactly that. If you plug in your experimental data and find the correlations between the entangled particles exceed a certain value, local hidden variables are ruled out. Unfortunately for realists, all experiments to date fall into this category.

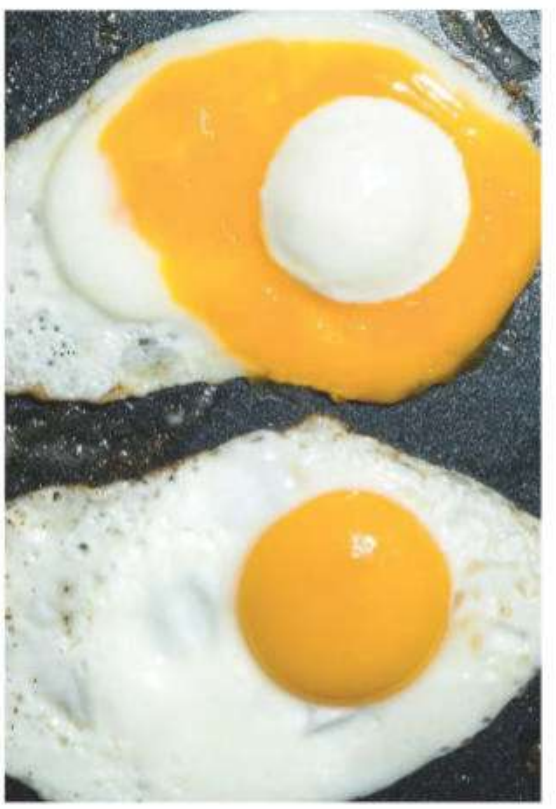
Using our most advanced devices and cutting-edge techniques to probe the nature of our world has put hidden-variable theories on shaky ground. These ideas, which were once promising a return to normalcy, had to be spookily non-local after all to fit with experimental observations.

Realism, then, is ripe for reinvention and Spekkens is giving it a shot. His strategy starts with a hidden-variable theory, but when issues with non-locality emerge, he doesn't want to compromise his realist values. Instead of allowing for non-locality or making some other exception, as other theorists have chosen to do, he would rather rebuild the foundations of the concept. "The approach I favour is to say, no, let's stick to our guns, on the idea that the wave function is really describing incomplete information," he says. "But let's change the framework relative to which we try to imagine reality."

But how does one reinvent the framework of reality? Spekkens points to one troublesome feature of quantum theory: it contains two different kinds of information. Or, in the words of physicist Edwin Jaynes, it is "a peculiar mixture describing in part realities of Nature, in part incomplete human information about Nature – all scrambled up… into an omelette". The key to resurrecting realism is to unscramble this omelette, says Spekkens.

He sees the ingredients of quantum theory falling into two categories. First there is causality, or how physical systems – particles and fields, say – relate to and affect each other, like a particle moving because another collided with it. Second is inference, or what we believe about physical systems and how we update our beliefs when we obtain new information, such as by making measurements of particles' mass. Quantum theory scrambles causality and inference into an eggy mess.

Physicists' ideas about how our world works are diverse; they might describe particles, strings or information. But generally they use numbers and equations to tackle causality, and a framework called Bayesian probability to describe what we infer about reality. Usually, these tend to get blended together in line upon line of equations.



AMERICAN GLITCH/OREJARENA & STEIN. COURTESY OF THE ARTISTS AND PALO GALLERY, NY

Some see the foundations of quantum theory as all mixed up

In contrast, Spekkens and his colleagues devised an approach where causality and inference are kept strictly separate. To drive the point home, in addition to traditional equations, they are employing diagrams like those usually used to describe electrical circuits – wires in the diagrams represent systems like sets of particles, and gates acting on those wires represent physical processes. Whether a wire is vertical or horizontal indicates whether it conveys a causal effect or an inference. Spekkens set all this out in a 2020 paper, written with his Perimeter Institute colleague David Schmid and John Selby at the University of Gdansk, Poland.

Their framework is an attempt to resurrect reality, but it invites a very different kind of thinking about it. Whereas we typically regard particles, fields and objects as reality's key constituents, the new framework puts the focus not on objects, but on the relationships between them. For Bob Coecke at the Colorado-based quantum computing company Quantinuum, who pioneered the diagrammatic language the team is using, the approach is a philosophical cousin of the relational interpretation of quantum theory, proposed by the physicist Carlo Rovelli. This says that we can't separate a description of an object from the other objects it interacts with. In other words, we can't consider reality to be made of real objects, only real relations.

So, have Spekkens and his colleagues really managed to reverse the whisk and make sense of the quantum omelette? Not everyone is convinced. Jonte Hance at Newcastle University, UK, says the notion of realism put forward in the new framework is "very non-standard". Hossenfelder has a similar worry. She thinks that the deep problems with making sense of quantum theory cannot be solved just by reinterpreting the maths. She also says that the framework contains a predefined notion of locality, which makes it inappropriate for studying non-local effects in an unbiased way. There may be value in unscrambling the omelette at this highly mathematical level, "but not the way they are doing it", says Hossenfelder.

Coecke, in contrast, says that using any

JOHN MACLEAN/MILLENNIUM IMAGES

other mathematical approach would make the unscrambling project impossible. And while Ana Sainz at the University of Gdansk says she isn't yet ready to go all in on realism, she nevertheless finds the new framework compelling and valuable. "This really describes the situation clearly," she says. "It's a tool for better understanding what's going on."

Since publishing their basic idea in 2020, Spekkens and his colleagues have taken on several staples of quantum theory, such as uncertainty relations, which set fundamental limits on how precisely properties of quantum objects can be measured. Across the board, they are trying to identify how much of each iconic quantum phenomenon must be attributed to something quantum that challenges our intuitive understanding of reality. Working with "toy theories" and analysing specific instances of quantum weirdness, they have been trying to unscramble the omelette, one metaphorical spoonful at a time.

Physicists tend to agree, though, that the decades-long lack of consensus about realism in quantum mechanics is unlikely to end

"They're trying to unscramble the quantum omelette one spoonful at a time"

Are we turning a corner in our understanding of the quantum world?

thanks to heady debates and mathematical abstractions alone. Attempts to redefine reality would turn more heads if they produced testable predictions. "I'm a philosopher, so I'm keen on people playing with formal systems and theories, but don't we want to make new predictions?" asks Ladyman.

Coecke is certain that those predictions are coming. In recent years, the swelling interest and investment in quantum computing has boosted studies of the foundations of quantum theory, and the two are bound to keep feeding into each other, he says. Hance says the fact that quantum computers rely on phenomena like entanglement to work may mean that this isn't just a debate between different philosophical camps, but it could have consequences for those who are trying to harness quantum states.

Selby, Spekkens's collaborator, says there is a way to test the new framework that would make a big splash, if they could actually try it. It builds on a thought experiment devised by physicist Eugene Wigner in the 1960s, known as the Wigner's friend thought experiment. In this scenario, a friend of Wigner's is observing a quantum system, like a particle in a box, in a lab. At the same time, Wigner is standing outside the lab and observing both his friend and the particle. The two can never agree on what exactly is happening to the particle, so their realities are mismatched.

Recently, there have been several proposals for implementing some version of this Wigner's friend situation inside quantum computers, which puts it at the top of Selby's wish list. He wants to use the new framework to look for a reality that Wigner and his friend do share after all. "It's really early days, but we have a framework and a target to aim for," he says.

Spekkens shares this view. "I want to resist the notion that coming up with an interpretation of quantum theories is somehow not going to be useful, that it's not going to add anything except maybe a story to the formalism," he says. "I think it will advance modern physics."

If he is right, then physicists can claim that reality is their business after all. ▮

Karmela Padavic-Callaghan is a physics reporter for *New Scientist* based in New York

Cloud watching

Clouds are a huge puzzle for climate science – but new ways of studying them are helping us fathom whether they will hasten global warming, finds **James Dinneen**

ONE of the rare places in New York City where you can get a good view of clouds is the Central Park reservoir. Looking north from its edge, a gap between the buildings is wide enough to see them roll in from the harbour. This is where climate scientist Kara Lamb suggests we meet for a bit of cloud watching.

When we do, the sky is crowded with fluffy cumulus beneath a ceiling of altostratus – one, I venture, is very like a whale. But Lamb, who studies clouds at the city's Columbia University, sees something less whimsical. "Clouds are fascinating because they are cool to look at," she says. "But I think about them more from a climate perspective." That means making sense of how the sunlight they reflect and the heat they trap below influences Earth's temperature.

What casual cloud watchers may not know is that determining how this balance will change in a warming world makes clouds the biggest unknown in predicting future climate change. Will the world warm by a manageable 1.5°C or a hellish 4.5°C, given a doubling of carbon dioxide from pre-industrial levels? Our poor grasp of clouds is the biggest culprit regarding this uncertainty.

But researchers are making progress. Lamb, for one, is focused on ice crystals in clouds, which play a surprisingly large role in their climate impact. Others use cloud chambers, with plans for one tall enough to produce rain. New satellites that can see inside storms and artificial intelligences that can simulate realistic atmospheres are also helping. Of course, we may not like the answers we get.

People have long puzzled over clouds. "Indeed, can anyone understand the spreading of the clouds and the thunderings of His pavilion?" asks the Bible's Book of Job. Walking with Lamb around the reservoir, she recalls rewatching Carl Sagan address the US Congress in 1985 to explain the basic science of climate change. At one point he mentioned uncertainties about future warming due to clouds. She is struck that not much has changed. "It's really the same fundamental scientific understanding he was expressing 40 years ago," she says.

We do know the features of clouds that matter most for Earth's energy balance. Top of the list are their total area, altitude and optical depth, which is a measure of how much light they block. For instance, low, bright clouds have a strong cooling effect because they reflect lots of sunlight without trapping much of the thermal radiation, or warmth, rising from Earth's surface. Conversely, high clouds like wispy cirrus can have a warming effect because they trap heat below them without reflecting much sunlight back into space.

We also know that while clouds contribute to cooling overall, climate change will alter their characteristics in ways that will reduce that cooling. We just don't know by how much. "It's a rather serious situation that we're in," says Graham Feingold at the US National Oceanic and Atmospheric Administration in Colorado. "Clouds are not well-understood enough for us to understand just how much they will be offsetting that climate change."

The global climate models we use to predict the climate decades from now rely on a combination of equations that draw on physics and statistics to represent the changing atmosphere. But these "general circulation models" are relatively coarse, and even when run on the most powerful supercomputers they are unable to resolve the small-scale processes that affect clouds. "It's like trying to study cells without a microscope," says Margaret Duffy at the National Center for Atmospheric Research in Colorado.

To make do, climate modellers use dozens of parameters based on observations of clouds to represent their "overall statistical effects", ›

ERIC S NEITZEL FIREGROUND COMMUNICATIONS LLC/ADOBESTOCK

says Lamb. "We can model maybe a single cloud or a field of clouds with relatively high accuracy, but if you want to take that and put it into a climate model, you have to simplify it a lot more." That simplification adds a large degree of uncertainty to our best estimates of how clouds will respond to rising temperatures.

Just how much uncertainty was made clear in a landmark study by Steven Sherwood at the University of New South Wales in Australia and his colleagues. They identified the six most important changes in clouds caused by global warming that will, in turn, influence climate change. These cloud feedbacks include less cloud cover overall, a shift of mid-latitude clouds towards the poles and more water in icy clouds (see "The cloud forecast", right). By their estimate, the total effect of the feedbacks ranged from no impact on the amount of warming to a substantial increase.

Erratic aerosols

The other major source of uncertainty alongside these cloud feedbacks is the role of particles suspended in the atmosphere called aerosols. From dust and the soot emitted by power plants to floating fungi, aerosols serve as seeds on which water droplets or ice crystals can form and create a cloud. "Clouds have a very, very difficult time forming in the absence of these particles," says Feingold. The size, type and number of particles affect the brightness of clouds by changing the number of droplets or crystals in them.

Current climate models can represent how aerosols affect the brightness of clouds fairly well, but the models don't do a great job of capturing the particles' knock-on effects, such as changes to the lifetime of a cloud, says Duncan Watson-Parris at the University of California, San Diego. Better understanding becomes particularly important as we reduce air pollution from burning dirty fuels, which decreases the aerosols in the atmosphere. Since 2020, for example, shipping has been forced to clean up its act. Yet estimates of how much warming this will cause vary widely. This is concerning given the current geoengineering debates about spraying aerosols into the sky to reduce warming, says Watson-Parris. "If we can't even measure the effect of reducing the emissions of the entire globe's shipping fleet by 80 per cent four years on, what hope do we have of managing an intervention?"

Even seemingly small details can have outsized significance. The current focus of Lamb's research, for instance, is how ice crystals grow in high-flying cirrus clouds.

The cloud forecast

Ongoing global warming will change clouds and those changes will, in turn, influence how much the planet heats up. These are known as cloud feedbacks. They come in many different forms, but three in particular are expected to increase warming.

LOSS OF CLOUDS AT SEA
Marine boundary-layer clouds – low-level formations found over much of the ocean – can cover more than a third of Earth's surface at once and have a substantial cooling effect by reflecting sunlight. However, warmer temperatures will lead to drier air above the ocean, which is expected to reduce the area covered by these clouds, resulting in the most significant of the warming cloud feedbacks.

HIGH CLOUDS GET HIGHER
Clouds rise when they are warmer than the surrounding atmosphere, and hence less dense than it. In a warmer world, the altitude at which they stop rising tends to increase. This is a problem because higher clouds have a stronger warming effect. Overall, this is expected to result in a moderate increase in warming.

FEWER CLOUDS OVER LAND
Hotter temperatures on land mean less water vapour in the air. This leads to fewer clouds at all levels, but especially those at low altitudes, which reflect lots of sunlight back into space. This feedback is expected to have a small warming effect.

STOCKIMO/ALAMY

ANDRII BILETSKYI/ALAMY

Crystal size matters. "It is one of the most important, sensitive factors in the model," says Lamb, who has been called the "ice-cloud puzzle master" for her work. Depending on how ice crystals in cirrus clouds are modelled, the predictions show a huge range of warming equivalent to doubling the amount of CO_2 in the atmosphere, she says. Yet there is no clear understanding of how aerosols and other factors affect the formation of this ice high in the sky. (Unfortunately, Lamb and I didn't see any cirrus during our walk in the park; the upper atmosphere was obscured by clouds.)

Nevertheless, researchers are making headway in their efforts to model clouds with greater precision. As a result, cloud-related uncertainty in the major Intergovernmental Panel on Climate Change (IPCC) reports on climate change decreased by around 50 per cent between 2014 and 2023. "The needle is gradually moving," says Watson-Parris. While that is good news for cloud science, it may not be good news for the climate: between the two IPCC reports, the projected warming effect due to cloud feedbacks increased by about 20 per cent. Still, the magnitude of this effect remains unclear, says Watson-Parris, with projections ranging from negligible to, in the most extreme emissions scenarios, apocalyptic.

The diversity of clouds is such that narrowing this range of possible futures

LOOP IMAGES/ALAMY

BLICKWINKEL/ALAMY; ANDRII BILETSKYI/ALAMY

High clouds such as cirrocumulus (far left, top) and cirrus (near left, top) tend to trap more heat than low and mid-level ones like stratocumulus (near left, bottom)

The EarthCARE satellite can see inside cumulonimbus storm clouds (far left, bottom)

“In June, the radar returned its first image, showing rain and ice falling out of a storm”

New Scientist Live

The future of climate modelling

Hear David Stainforth explain why we are going about climate forecasting all wrong **newscientist.com/nslmag**

won’t come from a single breakthrough, but from many researchers coming at the problem from different directions, says Feingold. For instance, two recent studies addressed uncertainties around how huge storm clouds called tropical anvil clouds will respond to warming. These develop when water and ice rising in a cloud hits the boundary between the troposphere and the stratosphere above it and spread out over an area much larger than the storm itself, resulting in a distinctive anvil shape. These formations can have a cooling or a warming effect depending on their area, altitude and thickness.

Earlier studies suggested global warming would boost the cooling power of such clouds by reducing the thinner areas of the anvil that produce a heating effect. But using high-resolution models, Adam Sokol at the University of Washington in Seattle and his colleagues found that the thick part of the anvil, which has a cooling effect, would decline even more. This would tip the balance towards a net warming effect. The second study, based on satellite measurements of tropical anvil clouds, discovered that they are unlikely to have a cooling influence as temperatures rise.

Other researchers are turning to cloud chambers to better understand cloud formation at a much finer level. “We have a machine in our lab that allows us to create a well-controlled, small piece of atmosphere,” says Raymond Shaw at Michigan Technological University, which hosts the only research cloud chamber in the US. “The big models are capturing all the details on a large scale. We have this box where we know almost everything… it’s reductionism at its finest.”

Lab-grown drizzle

The chamber enables researchers to scrutinise how the distribution of water throughout a cloud is affected by different factors such as aerosols, turbulence and temperature, information that is crucial to understanding its brightness. This can come down to tracking how colliding droplets interact in painstaking detail: “the millions of coalescences that lead to a raindrop”, says Shaw. To better understand such interactions, he is part of a consortium called the Aerosol-Cloud-Drizzle Convection Chamber (ACDC-2) collaboration. The group is designing a bigger cloud chamber that, at 10 metres high, will be tall enough for water vapour to form drizzle. “We’re not only going to have aerosols in clouds,” says Shaw, who thinks of the chamber somewhat like a particle accelerator for cloud science. “We’re going to have drizzle. So, we’re going to have collisions.”

Yet more researchers are seeking to reduce uncertainty by developing a new class of high-resolution climate models able to represent the atmosphere on a 1-kilometre grid. “Global cloud-resolving models are something I’m really excited about,” says Sokol. “Then it’s a realistic planet.” The drawback, however, is that these models require so much computing power they can only make near-term predictions or simulate limited areas, and they don’t yet include ocean, ice or biosphere dynamics. Here, machine-learning algorithms trained on those cloud-resolving models could play a supporting role. One such model, recently released by Google researchers, can accurately represent clouds using far less computing power than physics-based models. However, Watson-Parris says it is important to keep as much physics involved as possible to ensure projections are reliable.

Improvements to climate models will also come from better observations of real clouds. One important source of this is a satellite launched in May called the Earth Cloud, Aerosol and Radiation Explorer (EarthCARE). A joint mission of the European Space Agency and the Japanese Aerospace Exploration Agency, it is designed to answer questions about the sun-reflecting and heat-trapping effects of clouds and aerosols. It will provide the highest-resolution view of this yet, says Richard Forbes at the European Centre for Medium Range Weather Forecasting.

EarthCARE promises greater detail than other set-ups by combining multiple instruments on a single satellite to enable simultaneous measurements of clouds, aerosols and the incoming and outgoing radiation that influences warming. EarthCARE is also equipped with lidar, a laser-based detector, that can measure the shape and type of aerosols, and Doppler radar that can measure the speed of falling particles inside clouds. In June, the radar returned its first image, showing a cross-section of rain and ice falling out of a storm. The satellite is expected to begin delivering complete data in 2025, which will be used to test how well climate models are representing clouds, and to make improvements to them.

“EarthCARE is not going to give us all the answers,” says Forbes. “But I think it will give us a step change in terms of how we represent the clouds.” With all these efforts to solve the cloud conundrum, perhaps the fog is finally lifting. ▮

James Dinneen is an environment reporter for *New Scientist* based in New York

Brain savers

A greater appreciation of microglia, the army of mobile cells that tends to our neural pathways, is inspiring revolutionary treatments for dementia, finds **Grace Wade**

AS YOU read this sentence, an army of cells patrols your brain. These soldiers slip around neurons, using their gangly appendages to search for threats. If one of them detects a pathogen or injury, it springs into action. Swelling up and descending in a voracious attack, it releases chemicals that signal for its comrades to join the fight.

Known as microglia, these specialised immune cells are our brains' premier defenders. They protect us from invaders, clear away debris and maintain connections between neurons to ensure the brain remains in peak condition.

Yet, despite their vigilance, microglia can sometimes engage in friendly fire, with a growing body of evidence suggesting they may be the engineers behind some of the brain's most intractable conditions, such as Alzheimer's disease and depression. If that is the case, targeting our wayward defenders – or even replacing them with rejuvenated troops – may lead to exciting new therapies.

Microglia were discovered in 1919 by neuroscientist Pío del Río Hortega. While experimenting with novel ways of staining brain tissue, he stumbled across these new cells and named them after the ancient Greek words for "small" and "glue".

This turned out to be an ill-fitting description. Other than their splotchy appearance, microglia have few glue-like qualities. Instead, they are some of the most dynamic cells in the body, roaming the brain with spindly, tentacle-like projections that expand and retract in response to changes in their environment.

Microglia are a form of macrophage, a type of immune cell whose roles include regulating inflammation, controlling infection and gobbling up debris. However, unlike other macrophages, microglia have abilities uniquely adapted to the brain, such as shaping connections between neurons. These junctions, known as synapses, allow the cells to communicate with one another. Infants develop more synapses than they will need later in life, so they are "pruned" back over childhood and adolescence, creating more efficient neural networks – and microglia have a central role in this essential developmental process.

Beth Stevens has been at the forefront of this research. In the early 2000s, she was completing a postdoctoral fellowship at Stanford University, California, where she became captivated by the microglia's relentless poking and prodding in the brain. "No other cell in the brain has that ability to be so dynamic," she says. "To see that in real time led to all kinds of questions. What are they sensing? What are they doing when they touch a synapse or neuron?"

Her first clue came in 2007, when she and her colleagues discovered that neurons deposit a protein called C1q on synapses that is later removed. C1q belongs to the complement system, a group of proteins that tag debris, pathogens and other cells for macrophages to remove, kind of like an "eat me" signal.

The researchers showed that mice genetically engineered to lack this protein were unable to eliminate synapses, causing nerves in their eyes to develop incorrectly.

Stevens's subsequent experiments at the Broad Institute in Massachusetts used different imaging techniques to further characterise the interactions between microglia and these nerve cells in developing mice. This confirmed that microglia respond to complement proteins by engulfing the synapses they tag.

Pruning appears to occur across many different brain regions. Cornelius Gross at the European Molecular Biology Laboratory in Italy and his colleagues, for instance, have demonstrated that microglia trim synapses within the hippocampus of adolescent mice, an area that is critical for memory.

Going rogue

When it works well, this synaptic pruning prevents our brains from becoming a tangled mess of redundant connections. Unfortunately, a growing body of research suggests that our microglia can sometimes go rogue – and their malfunctioning may lead to various conditions affecting the brain.

People with multiple copies of a gene that encodes for the complement protein C4, which also triggers synaptic pruning, have an increased risk of developing schizophrenia, for example. Overexcited microglia may also be implicated in depression. Evidence is emerging that microglia in two brain areas critical for regulating emotion – the prefrontal cortex and the anterior cingulate cortex – become active during severe depressive episodes, and activation in the latter region correlates with severity. It may be that these microglia are struggling to regulate inflammation in the brain – a known risk factor for depression. This could explain the mechanism behind certain antidepressants, such as selective serotonin reuptake inhibitors (SSRIs), which trigger microglia to release anti-inflammatory molecules.

The most damning evidence concerns microglia's potential role in neurodegeneration. Consider Huntington's disease, a genetic condition in which nerve cells in the brain progressively deteriorate, leading to cognitive, mobility and speech issues. In 2023, Stevens's lab observed microglia in mice that were genetically engineered to show symptoms of the illness. They found that complement proteins spur microglia to prune synapses between the ›

RENAUD VIGOURT

cortex and striatum, two brain areas that deteriorate in Huntington's. By blocking these proteins, the researchers were able to slow synapse loss and prevent cognitive decline in the animals.

We don't yet have tools to measure complement proteins on synapses in living humans, says Stevens – but you can find signs of them in other tissues. As part of the same study, Stevens and her team analysed spinal fluid from 63 people with Huntington's disease. On average, those at later stages of the condition had 50 per cent more complement protein in their samples than those with early-stage Huntington's.

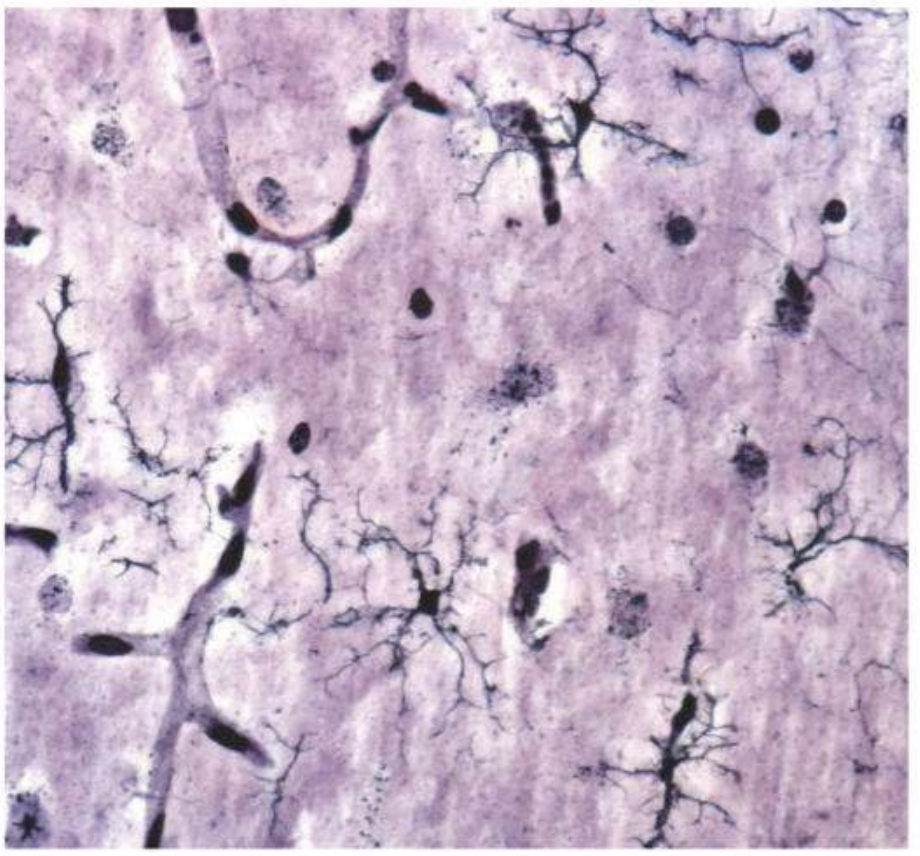
Overreactive microglia may also be implicated in the development of Alzheimer's. While the illness is often associated with the build-up of toxic amyloid plaques, synapse loss is actually the strongest correlate of cognitive decline in the condition.

A 2016 study by Stevens and her colleagues showed that C1q accumulates in the brains of mice that have been engineered to develop a rodent equivalent of Alzheimer's disease, even before the condition's characteristic plaques form. On average, the animals had three times the amount of C1q in their hippocampus and nine times the amount in their frontal cortex compared with those in a control group. The animals later experienced significant synapse loss in these regions, which are also vulnerable areas in people with Alzheimer's. Crucially, the team found that an experimental drug inhibiting C1q prevents microglia from excessively engulfing the animals' synapses.

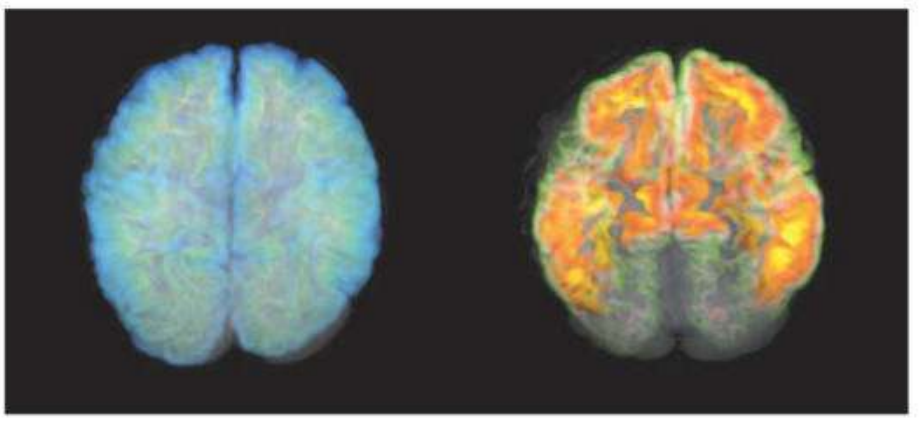
Our genes may mediate this process. For example, *TREM2* is strongly linked to Alzheimer's disease risk, and animal studies suggest that certain versions of this gene may protect against Alzheimer's by preventing microglia from pruning synapses in response to complement proteins.

Such findings don't exonerate amyloid plaques. These abnormal proteins tend to accumulate between neurons in regions crucial for memory and other cognitive functions – and microglia show heightened activity around them. "They really aggressively attack those plaques. They swell up. They look different. They proliferate. There are huge numbers of them," says Kim Green at the University of California, Irvine.

There is some evidence that microglia can first play a protective role by surrounding the plaques to control their spread. At some point in the condition's progression, however, they stop being effective. Tellingly, the *APOE4* gene variant, which is a well-established risk factor for developing Alzheimer's disease, appears to impair microglia's ability to neutralise the threat of these plaques in the brain. For instance, animal studies show *APOE4* disrupts communication between microglia and other immune cells in the brain, preventing the cells from clearing plaques.



SHUTTERSTOCK/JOSE LUIS CALVO



NEUROIMAGING AND INFORMATICS INSTITUTE/SPL

Left: In their resting state, microglia have tentacles that help to survey their surroundings

Below: A healthy brain (left) and a brain with the amyloid plaques that are thought to cause neurodegeneration in Alzheimer's disease

"Microglia act aggressively around Alzheimer's plaques. They swell up and proliferate"

"You've got this situation where perhaps an initial response of the microglia is actually helping the brain, but then, maybe later on, this response drives other parts of [the condition]," says Green. "And so everything becomes a lot more complicated."

Green and his colleagues' investigations into this process began in 2014, when he discovered a way of knocking out a brain's microglia. It turns out that the survival of these cells depends on a receptor called colony stimulating factor one (CSF1). When he and his colleagues treated mice with an experimental drug that inhibits CSF1, nearly all their microglia died. This offered an ideal way to determine what these cells do in the brain. "If you want to know something's important, you get rid of it and then see how a physiological process continues in its absence," he says.

In a 2019 study, Green and his colleagues used a CSF1 inhibitor to deplete microglia in mice that had been engineered to develop Alzheimer's. They found that amyloid plaques failed to form in the animals except in areas where microglia survived. It isn't clear why that is, but the researchers postulate it could be that the rogue microglia secrete chemicals that spur amyloid proteins circulating in the brain to form plaques.

If microglia are contributing to Alzheimer's disease and other forms of neurodegeneration, then new treatments might be able to target that wayward behaviour.

Simply removing the aberrant cells – as Green had done in mice – is unlikely to be viable. "Microglia are your protection against pathogens," he says. "I think that, if we were to

New Scientist audio
You can listen to many articles in our app – just look for the headphones icon **newscientist.com/app**

get rid of them, it wouldn't be good over the long term."

It may, however, be possible to deplete microglia and allow them to grow back in a revitalised form. Green and his team have found that when they stopped treating mice with CSF1 inhibitors, the roughly 1 per cent of microglia that survived burst into action. Within three days of removing the drug, about half of the animals' microglia had returned. By week two, levels were restored to baseline.

"I don't know of any other cell in the body that can proliferate as quickly and robustly as these remaining microglia," says Green. "I remember looking down the microscope and it's like, this can't be real. It's one of those things I think you only see once in a career."

Even more surprising was that the new cells appeared rejuvenated and behaved more like those seen in the brains of young mice. "The idea is that you can basically replace your old, aged, injured microglial tissue with a new one," says Green.

Repopulating the army

Researchers at Xiamen University in China and the Mayo Clinic in Florida have already tested this strategy. In 2023, they showed that depleting microglia in mice with Alzheimer's-like symptoms and then allowing them to repopulate reversed cognitive deficits. On average, the animals performed as well on certain memory tests as those without signs of Alzheimer's, suggesting microglial repopulation could be a viable strategy for treating the condition.

But Green is sceptical, since he suspects the microglia would return to their dysfunctional state over time. "The plaques would just activate the new microglia again, inducing them to take on the same inflammatory state as the old ones," says Green.

Nevertheless, it might treat conditions like stroke or brain injury where the initial threat is no longer present. For instance, Green and his colleagues have shown that depleting microglia in mice with damaged neurons in their hippocampus helps the animals recover. They performed better on memory tests, had lower levels of inflammatory molecules in their brains and had more synapses between neurons than untreated rodents did.

The ideal treatment would be one that could modulate microglia at different stages in a disease, switching on their inflammatory state when beneficial and turning it off once it becomes detrimental. This may not be as far-fetched as it seems.

"I remember looking down the microscope and thinking this can't be real – it's one of those things you see once in a career"

While completing a postdoctoral fellowship at Stanford University, Chris Bennett had what he calls a silly idea. A mouse in the lab had been genetically engineered to lack microglia. He decided to transplant stem cells – which have the ability to transform into other cell types – from a healthy mouse into this sick one.

The animal, which normally would have died in two weeks, survived for four months. When Bennett looked at its brain, he saw it was filled with stem cells that had become macrophages closely resembling microglia. "To me, this was a little bit of magic," he says.

The finding raises a tantalising possibility. If a stem cell transplant could replace microglia, we may be able to genetically engineer these cells to fix mutations or to have certain disease-fighting properties, such as secreting substances to protect neurons. "You could programme the cell so that if it senses one thing in the environment, it turns on a gene, but if it senses another thing, it turns off that gene," says Bennett.

The first challenge in making this dream a reality is finding a way to deplete microglia without killing off the transplanted stem cells. After starting his own lab at the University of Pennsylvania, Bennett and his colleagues engineered human stem cells to resist drugs that inhibit CSF1. They then transplanted these cells into mice treated with the inhibitors and found that they transformed into macrophages in the animals' brains, replacing the missing microglia.

They have since repeated this process in mice engineered to develop a rare genetic condition called globoid cell leukodystrophy, which is believed to be driven by aberrant microglia and results in severe neurodegeneration. The results of the study haven't been published yet, but Bennett says they found the transplant not only reduced neurodegeneration in the mice but doubled the animals' survival.

He and his team are now using this platform to develop new ways of treating Alzheimer's disease. Already, they are replacing microglia in mice with stem cells modified to have special receptors for identifying and clearing amyloid plaques. Whether this affects symptoms remains to be seen, says Bennett.

Both Green and Stevens believe microglia replacement holds significant promise for treating various neurological conditions. However, they both also acknowledge that it is still a long way away. "We have a number of obstacles to overcome before it becomes a reality," says Green.

For example, it isn't clear if stem cells can fully assume microglia's functions. Part of the concern is that unlike other macrophages, microglia originate from a structure called the yolk sac, which develops in the uterus during pregnancy. "We want to know what that means and when and how it might matter," says Bennett.

For any of these treatments to work, we will need a much more detailed portrait of the brain's guardians. "We need to understand what these microglia are doing in the brain, and then we need to work out how we can modulate them in the right way," says Green. Only then can we become the commanders of our brain's defence system so that its army of soldiers never turn against us again. ▮

We need radical new treatments for dementia

ALEXANDRA BEIER/GETTY IMAGES

Grace Wade is a US-based health reporter for *New Scientist*

The back pages

Puzzles
Try our crossword, quick quiz and logic puzzle p45

***Almost* the last word**
What is the largest size an animal can be? p46

Tom Gauld for *New Scientist*
A cartoonist's take on the world p47

Feedback
Pressing questions about poking cysts and picky eaters p48

Twisteddoodles for *New Scientist*
Picturing the lighter side of life p48

Stargazing at home

Blazing forth

Comet Tsuchinshan–ATLAS is expected to grace our skies next month. **Abigail Beall** is hoping for a dazzling display

Abigail Beall is a features editor at *New Scientist* and author of *The Art of Urban Astronomy*. Follow her @abbybeall

What you need

A stargazing app such as Stellarium

Stargazing at home appears monthly. Share your stargazing successes with us on X and Instagram @newscientist using the hashtag #NewScientistStargazing

Next week

Mathematics of life

ONE of my favourite memories of July 2020 is standing outside on a clear summer evening looking at a beautiful comet, known as C/2020 F3, or Neowise, through a shaky pair of binoculars. It was a strange period, to say the least, but stargazing made me feel closer to friends and family who share this interest, who I couldn't be with in person due to covid-19 restrictions. And glimpsing Neowise (pictured) was a true highlight for me during that time.

If you missed out on seeing it you won't get another chance, as it won't be back for a few thousand years. But don't worry, because next month a different comet is set to grace our skies that could be brighter than Neowise – as long as it stays intact.

Since July, comet C/2023 A3, also known as Tsuchinshan–ATLAS, has been out of view as it rounded the sun. This object, which was visible through small telescopes earlier in the year, is expected to pop up again by mid-October. At this point, you might spy it with the naked eye at night.

Like all comets, Tsuchinshan–ATLAS is unpredictable. It was discovered in February 2023 by astronomers at an observatory in Sutherland, South Africa. However, it was later found to have been spotted earlier than that, but not identified as a new comet, at the Purple Mountain Observatory in Nanjing, China, in early January.

At first, it was being called the comet of the century. This was because its peak brightness was predicted to exceed that of Jupiter at its brightest, only being outshone by a full moon.

ADVENTURE_PHOTO/GETTY IMAGES

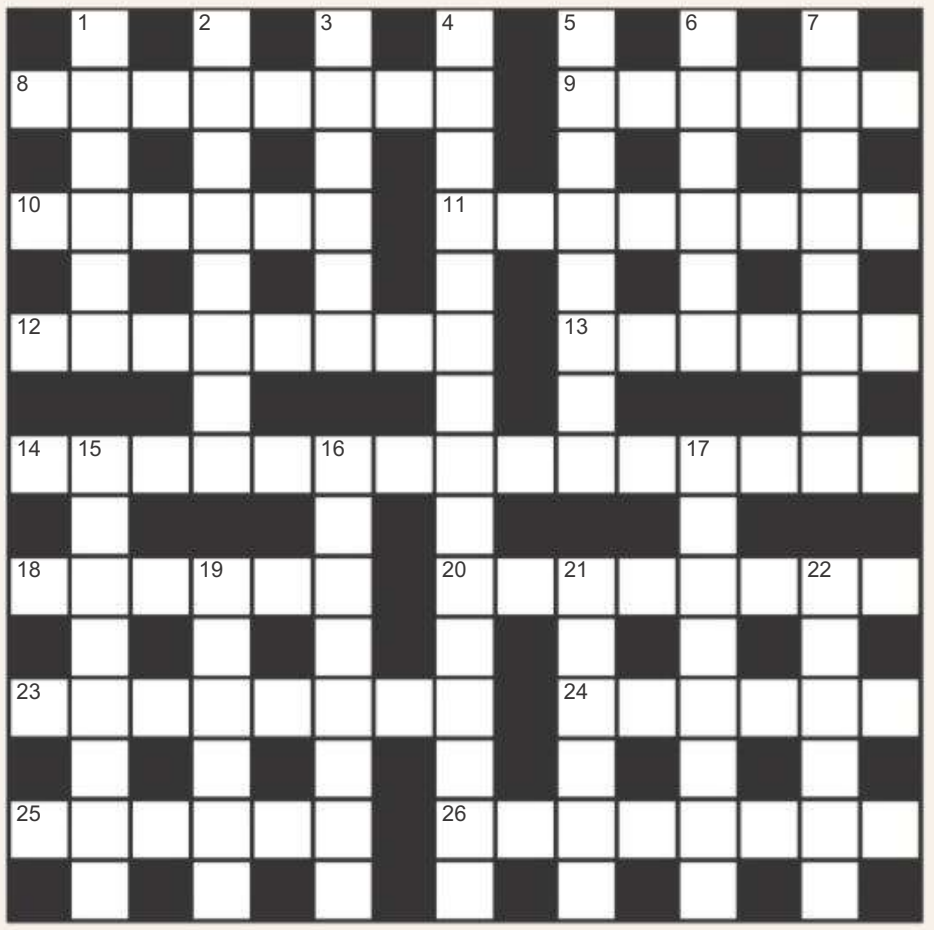
Now, as we have learned more about the comet and its trajectory, the expected brightness has been revised down. It all depends on how active the comet is, but optimistic predictions are that it will shine on a par with Vega, one of the brightest stars in the night sky. If this is the case, it will be clearly visible with the naked eye. But others think it will disintegrate and fall apart before it reappears, meaning it won't be visible at all.

I will keep my fingers crossed that comet Tsuchinshan–ATLAS does make an appearance. If so, you should be able to see it after sunset in the west from around 15 October, or perhaps even sooner. It will be between the constellations Virgo and Serpens. If it is visible, you should be able to see it from anywhere in the world. But use software like Stellarium Web to check exactly where the comet will pop up in the place you live, and keep an eye on updates about its brightness.

This time round, I am expecting to be in my own state of semi-lockdown, since my first child is due in September. I will be leaving this column in the capable hands of Leah Crane, *New Scientist*'s expert in all things space. And I won't stop stargazing. I plan to spend some of my sleepless evenings watching the sky in the knowledge that fellow enthusiasts will be doing the same. ▮

These articles are posted each week at newscientist.com/maker

Quick crossword #166 *Set by Richard Smyth*



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

8 Canine (3,5)
9 Stick (6)
10 White ___, mineral turpentine (6)
11 Sand or silt, perhaps (8)
12 Mediterranean wind (8)
13 Hazardous (6)
14 1985 sci-fi action comedy (4,2,3,6)
18 ___ ray, astroparticle (6)
20 Of flowers, in a cluster (8)
23 Measurement of computer performance (8)
24 Endocrine or exocrine organs (6)
25 Cut in two (6)
26 Investigative medical device (8)

DOWN

1 Short-sighted (6)
2 Sci-fi TV programme first broadcast in 1966 (4,4)
3 Relating to a major blood vessel (6)
4 Type of healthcare professional (15)
5 Scalp condition (8)
6 One of the 24 Acrosses (6)
7 Relocate (8)
15 Eating disorder (8)
16 Touch; kiss (8)
17 Eardrum (8)
19 John ___, anti-virus software creator (6)
21 Immature swan (6)
22 Na (6)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #268
set by Bethan Ackerley

1 When two substances cannot mix to form a solution, such as oil and water, they are known as what?

2 Which of the following trees isn't a gymnosperm: the giant sequoia, the ginkgo or the European beech?

3 Fossils of the spear-shaped guards of which ancient creatures were historically known as devil's fingers or St Peter's fingers?

4 In which organ of the body would you find Bachmann's bundle?

5 Of the 88 modern constellations designated by the International Astronomical Union, which covers the largest area of the night sky?

Answers on page 47

BrainTwister
set by Peter Rowlett

#36 Prime generators

In 1772, mathematician Leonhard Euler noticed that the value of the polynomial $x^2 + x + 41$ is a prime number if you set x=0. He also spotted it is prime if x=1 and it keeps on giving primes for values of x up to 39.

If we use $x^2 + x + 3$ instead, and put x=0, we get 3. Using x=1 gives 5, but the pattern then breaks because x=2 gives 9, which isn't prime. So, $x^2 + x + 3$ generates a sequence of two primes.

How many primes in a sequence are created by $x^2 + x + 5$ using x=0, 1, 2 and so on?

For a prime p, we can generate a sequence of primes using $x^2 + x + p$ with x=0, 1, 2 and so on. Which value of p between 220 and 230 generates the longest sequence of primes?

I noticed that for all the values of p with a polynomial that generates multiple primes, p+2 is also prime (we call this a pair of twin primes). Why is this? Will it always be the case?

Solution next week

Size matters

What is the largest size an animal can be?

Mike Follows
Sutton Coldfield, West Midlands, UK
It is usually claimed that the blue whale is the biggest animal that has ever lived on Earth. The largest recorded mass of a blue whale is around 190 tonnes, though a bigger individual has been observed that might have tipped the scales at 250 tonnes. However, this might yet be surpassed by a marine reptile that lived at the same time as the dinosaurs, called *Ichthyotitan severnensis*.

The so-called square-cube law, something first observed by Galileo Galilei in 1638, sets an upper limit to the size of land animals. If the size of an animal is scaled up, the cross-section of its bones increases by the square of the scaling factor and its volume (and hence its mass and weight) would be cubed, doubling the stress on its bones. This can be visualised with one die alongside eight dice arranged as a cube (two by two by two).

For example, doubling the height of an animal would mean

"While coloniality does allow some organisms to reach huge sizes, the trade-off is that such life forms lack the means to move"

the cross-section of its bones would increase by a factor of four, but its weight would increase by a factor of eight. Further increasing the size of the animal means that a threshold would be reached where the bones of an animal would be unable to support its body weight without breaking – or the animal would need to modify its behaviour, which is why elephants avoid jumping.

In contrast, marine animals like the blue whale can take advantage of their buoyancy to scale up in size without significantly increasing the stress on their bones. Reptiles have slower metabolisms compared with mammals, so can divert a bigger proportion of their food intake to increase their body mass, which is why there were so many big dinosaurs.

In 1976, Edwin Salpeter and Carl Sagan co-wrote a paper speculating about the possibility of life in the atmosphere of Jupiter. The imagined ecosystem included "floaters", kilometres in diameter, which would hitch a ride on the convection currents there.

While floaters are unlikely to be discovered on Jupiter, scientists in search of extraterrestrial life need to be open to the possibility of life forms that elude our imaginations.

JOHN M. CHASE/ALAMY

Could an advanced technological civilisation develop without the wheel?

This week's new questions

Round in circles **Would it be possible for an intelligent species to develop an advanced technological civilisation without the wheel?** ***Joe Roberts****, St Austell, Cornwall, UK*

Rogue agent **If an Earth-sized rogue planet passed through our solar system, missing the planets, how much disruption would it cause?** ***David McKenzie****, Launceston, Tasmania*

Neale Monks
Berkhamsted, Hertfordshire, UK
Colonial organisms, formed from genetically identical but morphologically specialised units working together, can be very large. Arguably, some can be seen from space. For example, some corals can end up growing into massive reefs.

Likewise, social insects achieve similar end results by working cooperatively. In the case of these animals, such as bees and termites, the colony or nest is arguably the organism. If you learned the MRS GREN requirements of life at school, you may recall it is the colony, not the individual insect, that satisfies all seven criteria of life (movement, respiration, sensitivity, growth, reproduction, excretion and nutrition). The same holds true for all colonial organisms, including coral, sponge, bryozoan and siphonophore species.

The biggest corals are massive, with at least one exceptionally large *Porites* coral reaching 22 metres high and 8 m wide. Although corals do have a simple nervous system, it isn't as fast or well coordinated as that in many other animals, so communication between polyps is relatively small and limited to simple reflexes. As they don't move about and tend to rely on filter feeding or even symbiotic algae for nutrition, this probably isn't a major issue for them. But it is probably fair to say that while coloniality does allow some organisms to reach remarkably large sizes, the trade-off is that such life forms lack the means to move around.

Social insects can form colonies containing mind-blowing numbers of individuals, stretching across dozens or hundreds of miles. But coordination between the individual insects, let alone separate colonies, is relatively slow. An ant that has discovered food has to walk back home and tell its sisters, then those ants will head back out following some sort of chemical trail.

While certainly clever, this isn't anything like as fast as the hand-eye coordination we take for granted when we see something edible and lift it up to our mouth.

So, is there an uppermost limit on animal size? Probably, and one thing to consider is surely the rate at which information can be spread throughout the organism if it is going to be quick enough to elicit a useful and timely response.

Herman D'Hondt
Sydney, Australia
If we move outside the animal kingdom, much larger organisms can be found.

Sequoias can be 115 m high. An aspen tree in Utah called

Want to send us a question or answer?
Email us at lastword@newscientist.com
Questions should be about everyday science phenomena
Full terms and conditions at newscientist.com/lw-terms

Tom Gauld
for New Scientist

Pando cloned itself to form a 430,000-square-metre forest. A *Posidonia australis* "seaweed" in Australia's Shark Bay cloned itself into a 180-square-kilometre patch of seagrass.

If life exists on another planet, it will be affected by that world's gravity, with lower levels allowing animals to grow larger. And it is possible that evolution on other planets would come up with different body systems, with sizes that are anyone's guess.

Balancing act

Is there exactly the same number of electrons as there are protons in the universe? Is that also true of Earth at any given moment?

Eric Kvaalen
Les Essarts-le-Roi, France
In most stars, hydrogen is turning into helium, and the process starts with two protons coming together to form helium-2. This usually splits back apart very quickly, but sometimes one of the protons turns into a neutron, a neutrino and a positron (a positively charged anti-electron). The positron annihilates quickly with an electron.

"To own a conscious intelligence would amount to slavery. Such an AI would be entitled to start an abolition movement"

Even though protons in stars last millions or billions of years and the positrons last only a fraction of a second, there are positrons in the stars, and this means that if the star is neutral, there are more electrons than protons. Earth is constantly bombarded by cosmic rays, which are mostly made up of protons. This must give Earth a positive charge, but one that doesn't continue to grow because it will attract electrons from the solar wind. So there may be more protons on Earth than electrons.

On the other hand, when a high-energy proton hits the air, it creates a shower of other particles, including lots of electrons and positrons. That gives an excess of electrons over protons locally. In any case, it seems certain that there isn't the same number of protons as electrons, neither in the universe as a whole nor on Earth.

Switched on

Will we ever be able to tell if an AI gains consciousness? (continued)

Bernd-Juergen Fischer
Berlin, Germany
To own, buy or sell a conscious intelligence would amount to slavery. Such an AI would be entitled to start an abolition movement. That would be the point we could no longer deny they had gained consciousness.

John Pahl
London, UK
There could be one way to test whether an AI is conscious: don't include any reference to consciousness in the data sets used to train it and see if it asks what this feeling of being aware is. ▮

Answers

Quick quiz #268 *Answers*

1 Immiscible

2 The European beech

3 Belemnites

4 The heart

5 Hydra

Cryptic crossword #143 *Answers*

ACROSS 7 Halley, **8** Chorea, **9** Zeus, **10** Retiform, **11** Petards, **13** Sepal, **15** Rondo, **16** Carrion, **18** Smallpox, **19** Uvea, **21** Tumour, **22** To date

DOWN 1 Wave, **2** Flesh and blood, **3** Hydride, **4** Acute, **5** Coffee grounds, **6** Years ago, **12** Enormous, **14** Bauxite, **17** Sperm, **20** Et tu

#35 Cube cuts *Solution*

To make four pieces, we just need two cuts. One would cut a 3-by-3 slice off one side of the cube, then we just keep the pieces together and cut along any plane that passes through both.

If each cut you make splits the cubes in half, it should be possible to create as many as $2^5 = 32$ smaller pieces in five cuts. In this case, however, the first cut will always split the 27 cubes into pieces of size 9 and 18, and then there is no way to split the 18 cubes in only four cuts (even if we split them in half each time, 2^4 is only 16).

If we can only cut one piece at a time, this will take 26 cuts: each cut increases the total number of pieces by 1.

Suck it up

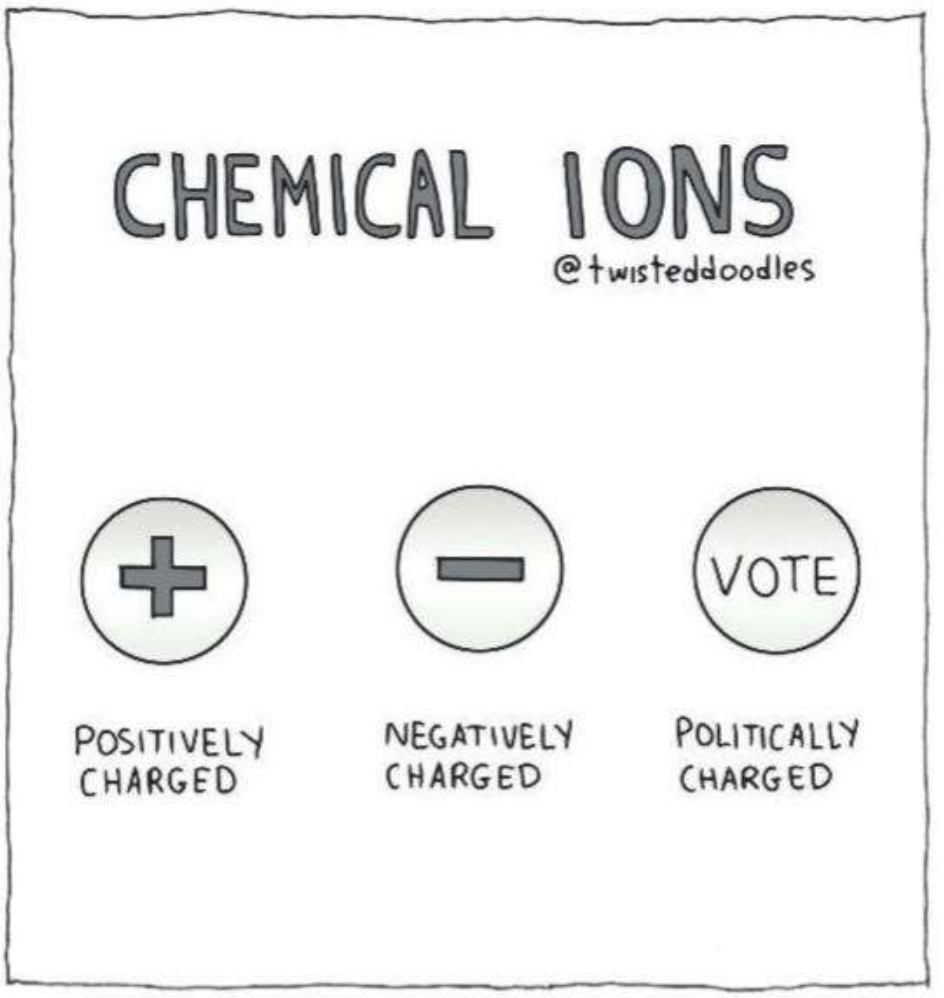
Reader Simon Leach responded to Feedback's call for papers in which The Title Tells You Everything You Need to Know with a cheery "Well, you asked for it!".

The "it" was a copy of a report published in the *British Medical Journal* in 1980 under the headline "Penile injuries from vacuum cleaners".

"The title," says Leach, "contains everything you need to know. However, the report answers every question that might occur to you as well. The last sentence summarises by saying 'The present patients may well have thought that the penis would be clear of the fan but were driven to new lengths by the novelty of the experience and came to grief'." Leach adds: "As junior doctors we may not have read the *BMJ* as assiduously as we should, but we all read this one!"

Feedback muses that, whether professionally or personally, one should love one's vacuum cleaner wisely, but not too well. If you know of another published research study with a title this satisfyingly complete, please send it to: Telltale titles, c/o Feedback.

Twisteddoodles *for New Scientist*



Got a story for Feedback?

Send it to feedback@newscientist.com
or New Scientist, 9 Derry Street, London, W8 5HY
Consideration of items sent in the post will be delayed

How to de-cyst

Shiheng Zhao and Pierre Haas grossly grab your attention with the title of their study: "Mechanics of poking a cyst". That done, they shift into a less folksy tone.

Zhao and Haas are based at two of the three Max Planck Institutes in Dresden, Germany. They demonstrate how to shepherd a discussion so as to minimise the yucky and maximise the technomechanical.

"Just as one is wont to poke the fruity wares peddled in supermarkets to evaluate the immediacy of their comestibility," they begin, "indentation of biological samples reveals mechanical properties that are intrinsically linked to their biological function."

After that, it's all about "the relation between the indentation force F and the displacement e of the indenter" and "calculation of the elastic deformation gradient".

If you have a fascinating skin ailment but also have friends who cringe when you tell them about it, try using Zhao and Haas's genteel phrasing. Cysts, they point out, are simply "spherical monolayers of polarised cells surrounding a fluid-filled lumen".

Hamburgers on meat

Several hundred Hamburgers – residents of the city of Hamburg, Germany – answered surveys about three kinds of sausage. These were select Hamburgers, all of a certain age range.

The survey's senders, Stephan G. H. Meyerding and Magdalena Kuper at Hamburg University of Applied Sciences, limited their questions to these varieties of sausage: "Meat, plant-based or in-vitro salami."

Meat-based is the most traditional of the three salamis, while the plant-based kind has grown in popularity in recent decades. In-vitro salami – made using stem cells – is the newest comer, still finding its way from laboratories to dinner tables.

The researchers' aim? "Explaining food product choice of generation Y and Z in Germany through carnism and the core dimensions of the food-related lifestyle scale."

The verdict, in their data, seems to them clear: "The majority of Generation Y and Z in Germany prefer vegan meat over real meat, and in-vitro meat is more popular than beef or pork meat."

That verdict doesn't seem as meaty as it might be if the study is done anew some years from now. "In-vitro meat," say the researchers, "is still unknown and not yet on the German market."

Eat your liver

The old complaint that kids don't want to do what adults tell them to do has new confirmatory evidence. "Children don't like eating what they're supposed to eat..." according to the title of Vira Réka Nickel's study about childhood nutrition.

Nickel is based at the Institute of Ethnology in Budapest and has gathered info about the past hundred years or so of "public catering for children in Hungary".

During that time, eating and food preparation habits changed drastically in the nation, driven, says the study, by "the obligation to provide public catering and the general obligation to work".

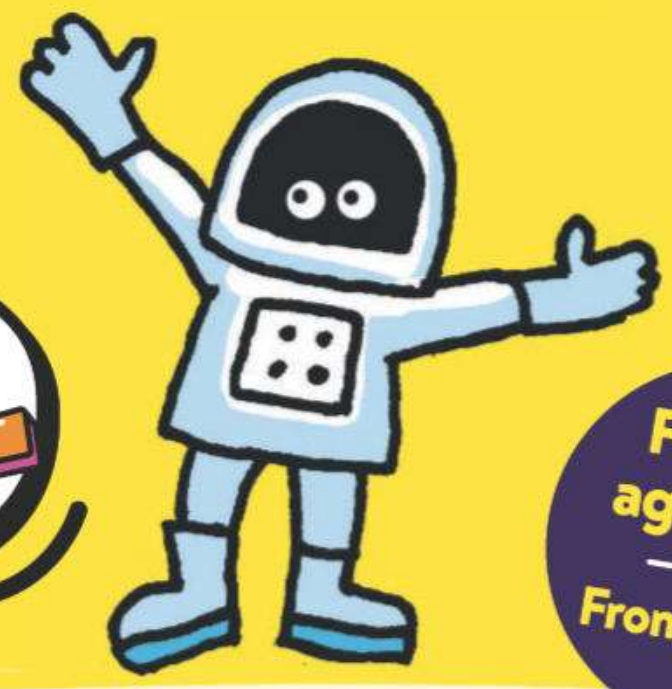
Nickel illustrates the they-don't-like-it problem with photographs, one of which bears the caption "Fried, breaded luncheon meat with creamed split peas is one of the 'classic' school meals, although it has never been one of the most popular".

There are certain meals that many children refuse to touch, a reluctance Nickel explores in some depth: "During our research, fried liver was one such meal. In Eger, the problem was addressed by serving only rice if the child did not want the liver. In Ózd, the children were not given this option. The catering manager in Ózd drew my attention to an important fact when we asked about the possibility of serving children only the part of their meal they wanted to eat: 'it's against the law. The parents have paid for it'."

Statistics and baboons

"Can non-human primates perform linear regression on a graph?" ask Lorenzo Ciccione and colleagues in a study that refers to "the baboon as a statistician". Their tentative answer: somewhat, to a degree that "varies among individuals". ▮

Marc Abrahams



For kids aged 7-14

From £26.99

Get ready. Get set. Get... What on Earth! Magazine

What on Earth! Magazine is a monthly factual magazine that's the fun, fascinating way for kids aged 7-14 to fall in love with reading and learning.

Subscribe today and get...

- **FREE Eco Drawstring Bag made of recycled material**
- **FREE £15 book voucher**
- **All their favourite topics: animals, space, science, history, sport, inventions, discoveries and much much more!**
- **Puzzles, quizzes, games, home activities, jokes and riddles**
- **The magazine delivered in your child's name every month**

Subscribe now

Save 10% + get a FREE £15 book voucher + bag

Visit www.whatonearth.co.uk/ns7 or call 01778 392479 quoting NS7

‘Brightling’

Despite its 10.95mm height, the Trident C60 Pro 300 ‘Lumiére’ leaps from your wrist. (Just like it jumped off this page.) Its brightness results from proudly protruding indices and the logo they encircle. Featuring facets finely machined to tolerances of 0.03mm, these mini-monoliths are super-legible in daylight. But it’s the Globolight®, the unique luminous ceramic from which they’re hewn, that produces their astounding, super-brilliance at night. And inspired this timepiece’s name. The light show doesn’t end there. Carved from titanium, the 41mm case incorporates a second sapphire crystal displaying its super-accurate movement. But it’s not the back of this beautiful tool watch you’re buying into. Is it?

Do your research

Christopher Ward

christopherward.com